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TABLE OF CONTENTS

PRINCIPAL ARTICLES

North America

South America

Europe

Departments

Separate Illustrations

THE GEOGRAPHICAL REVIEW

CONTENTS FOR JANUARY, 1924

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THE GEOGRAPHICAL REVIEW

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NORTH AMERICAN INDIAN DWELLINGS

By T. T. Waterman
Museo Nacional, Guatemala

The Indians of North America occupied an enormous area, in which they encountered every variety of climate and scenery. In the various regions were evolved different ways of living and, especially, different forms of dwellings. The forms of Indian habitations were affected by climate and were modified according to materials available. House types of different regions accordingly offer marked contrasts. Some were simple; so simple that nothing could be more startlingly primitive (see the Paiute village shown below, Fig. 21). Some were very large—hundreds of feet in dimensions. Some were made of tremendous beams in a cyclopean style of carpentry. In at least one area stone masonry was developed, and the ruins of the ancient stone structures are imposing even today (see, for example, Pueblo Bonito, Fig. 13). Some Indian dwellings are picturesque, some are odd, and all are interesting. The way in which geographic forces operated in shaping or modifying the habitations of the Indian tribes is an interesting matter for investigation. The subject may well be introduced by glancing at two habitation types, both important and characteristic but very different—the wigwam and the tipi.

The Wigwam

The word "wigwam," in the language of the Algonkian-speaking peoples of the Atlantic side of the continent, means simply a dwelling. The term was applied by Europeans to the types of structures they encountered among the tribes of the middle Atlantic states. These habitations were essentially permanent structures. They were grouped into regular towns, with squares and public buildings, were fortified, and in many cases defended with earthworks. Movable tents were not in use in this region; and the wigwam is not by any means a tent. It was not a type of conical lodge, like those used farther west, but it either had an arched-over roof or was hemispherical. The simpler forms were shaped like half an orange, but the

FIG. 1

FIG. 2

FIG. 1—An Ojibwa wigwam in Minnesota. The habitation is covered partly with birch bark, partly with bulrush mats. (After D. I. Bushnell, Jr., from a photograph in the collection of the Minnesota Historical Society.)

FIG. 2—An elongated wigwam, large enough to accommodate fifty people, as found among the Menominee, west of the Great Lakes. (Photograph from the collections of the Bureau of American Ethnology.)

FIG. 3

FIG. 4

FIG. 3—A lodge of birch bark built by Passamaquoddy Indians in the grounds of the Smithsonian Institution, Washington. Its faithful resemblance to the old style habitations is remarkable. It was erected entirely without nails. (Photograph by DeLancey Gill, courtesy of the Bureau of American Ethnology.)

FIG. 4—A Choctaw house in Louisiana, covered with palmetto. (By courtesy of the Bureau of American Ethnology.)

vast majority were elongate. The Sac and Fox Indians, to mention no others, live in this type of dwelling even today. The wigwam in many cases had room enough to accommodate a large number of families. It would contain, in addition to benches and sleeping platforms, space for a year's supply of food.

The eastern Indians who used this form of dwelling were by no means nomadic savages, living by plunder and the chase. They were peaceable farmers, when circumstances allowed them to be, living on products quite familiar on our own tables—corn bread, squashes, plums, wild grapes, berries, maple sugar, and meat when obtainable. The settler on the Atlantic seaboard got his food plants, his maple sugar, and his custom of holding "husking bees" directly from the Indian.

This settled, agricultural mode of life together with the wigwam was distributed over a large part of North America. Briefly, it went wherever the rainfall and the temperature permitted cultivation of maize. This plant grows naturally only where the hot growing season is accompanied by rains. Every one who has crossed the continent has been struck by the change in the face of nature in the region of the 100th meridian, the longitude of central Kansas. Westward lies the region of dry as contrasted with rainy summers. Corn can be grown in the drier west only with artificial irrigation. Wigwams and the easy cultivation of maize go together and are characteristic of eastern North America.

The aborigines in this eastern area being sedentary in the same sense as the present population is, it follows that their houses should be permanent, not movable. The house structure consisted of a framework of poles, planted solidly in the ground and bent over to form arches, covered in with some light material. The form was practically determined by the nature of the forest, for the timber consists in large part of hard woods, which could not readily be worked up by primitive implements. The material used to cover the house was of considerable variety. In the Atlantic region the most popular covering was bark, which was readily available, both in large quantities and in large pieces, from a variety of trees—among them birch, elm, hickory, and ash. In areas where large sheets of bark could not readily be obtained, other materials were substituted. Thus, beyond the westward margin of the forested area, on the plains of Arkansas, houses of a similar framework of poles were thatched over with grass, as among the Wichita. Among the Ojibwa and Menominee, in the lake region of Minnesota, matting made of rushes was employed as covering material, being there more readily available than bark. It is noteworthy in a general way that as we go farther north the houses become simpler and simpler, until in the far north, among the Cree or the Salteaux, the structure is just a simple framework of light poles in the shape of a flat cone, covered over in any fashion with sheets of bark, matting, or what not.

The original population in this eastern area was dense as compared with that farther west, because of the greater productivity based in turn on the

FIG. 5—A famous Indian town of early colonial days; the village known as Secotan, in what is now North Carolina. All the tribal activities are in full swing; tobacco is growing in plots; and in the distance a man in an elevated shelter is watching the cornfields. (From Thomas Hariot: A brief and true report of the new found land of Virginia, 1588.)

occurrence of summer rains. It was large enough, for instance, to build numerous and quite substantial earthworks. These included burial mounds, ceremonial mounds, and fortifications. The mounds were so widely scattered

and some at least of the fortifications so tremendous and impressive, that we have come to refer to these peoples as "mound builders." The idea that the mound builders were different in any respect from other Indians is quite without foundation. Some of the mounds were built, in fact, after the coming of the whites, as is proved by the presence in them of European objects—medals, scissors, porcelain, pewter, and iron knives. Yet all the Indians in the Ohio Valley at the moment when the settlers came into that

FIG. 6—Grass-covered lodge of the Wichita tribe. (From a photograph in the collections of the Bureau of American Ethnology.)

region were not numerous enough to man the ramparts of the old Indian earthwork known as "Fort Ancient." This decline may be attributed to a sudden movement of the erstwhile stationary population from the area, owing probably to the introduction into America of the horse. The Indians were originally without horses and, in North America and Mexico, without burden animals of any description except the dog. In fact, American Indian society, speaking generally, developed a civilization without draught animals or vehicles. The introduction of the horse by the Spaniards led to a great economic transformation, a general drift of the population to the Plains, where pursuit of the buffalo was suddenly made very easy and sensationally successful. Here a peculiar way of living developed, apparently after the Spanish conquest of Mexico but long before the inroad of English-speaking people from the Atlantic side. Let us turn to the habitations of the "horseback" Indians of the Plains.

Dwelling of the Plains Indians: The Tipi

The history of the Plains region of North America does not go back very far. When our historical knowledge begins, the tribes were already in possession of horses, and a novel mode of existence had already developed. What conditions had been before that time we can only surmise from a few survivals and from archeological evidence obtained in the old sites. Some very quaint and curious information has recently been brought to light in the latter way. What we consider the typical mode of existence of the Plains Indians is therefore only the latest phase of their mode of life and a very novel and highly modified phase at that. Moreover, as we have already remarked, this highly modified mode of existence has commonly come to be considered as the mode of life typical not only of the Plains Indians but of all Indians. The appearance, dwellings, and even costume of the modern Indian of the Plains is what comes to mind when anyone says "Indian."

Physically the Plains Indians were—and are—a very fine people, possessing the gift of wearing costume strikingly. This trait is shared by men and women. The war bonnet of eagle feathers, worn by the men and never by women (the Indian woman on the old-style United States copper penny to the contrary notwithstanding), is the most picturesque headgear worn by any tribe of people anywhere. When the Treasury Department in improving the art exhibited on our coinage wished to select a fine-looking Indian as model for the head on the five-cent piece, they turned to a member of one of these Plains tribes.

The dwelling of these Indians was the tipi, or teepee. That this structure should ever be mixed up with the wigwam is surprising, for the two are very unlike. The tipi is a movable tent, covered with skins, conical in form, with the poles of the framework jutting out of the top. It forms a very tidy, serviceable, and picturesque habitation and furthermore one that is quite distinctive. Tribes like the Yakuts of Siberia have a tent that is hemispherical, not conical, and is covered with felt, not skin. Tents of the Lapps and Samoyeds likewise differ from the tipis: the tipi cover is cut, or "tailored," in a pattern that is perfectly distinct.

The tipi, exclusive of the furnishings within it, consisted of two parts, a set of poles for the framework and a cover of dressed buffalo hides which were carefully tailored and stitched together. This was stretched over the poles and pegged down to the ground when the structure was set up. The poles, preferably of the so-called lodgepole pine, were long, slender, and elegant—long enough to project eight or ten feet above the top of the tent.

In setting up the tipi two poles were put together in the form of a V and lashed at their intersection with the end of a rope, the rest of which was left dangling. A third pole was then fastened to the apex of the V, and the three were raised into the air to form a tripod. This was the foundation of the tent. Additional poles were carefully laid in place, the woman—for this

was women's work—tossing a turn or hitch of the rope over each new pole and binding the whole firmly together. Certain tribes, like the Blackfeet, used four poles, not three, for the foundation of the tipi. In any case, the finished framework was a smooth conical structure of bare poles. The cover

FIG. 7—Tipis, photographed among the Sioux of the Plains, about 1870. This unusual old photograph shows the lodges with their "ears," together with great quantities of drying buffalo meat. Women are dressing buffalo hides, numbers of which are pegged out on the ground. (After D. I. Bushnell, Jr., through the courtesy of the Bureau of American Ethnology).

was next hoisted into place and stretched around the framework, being pegged down to the ground all around. Where the two edges of the cover met in front, a set of long slender wooden skewers were used to fasten them together. The cover was so shaped that at the top of the tent there was an opening left for the escape of the smoke. Flanking the smoke hole were two flaps known as "ears." Into a pocket at the tip of each ear was inserted a long slender pole, and these poles rested against the tent, the lower ends

extending back of the structure and resting upon the ground. With the help of these two poles the "ears" were moved this way or that, according to the direction of the wind. A tipi without "ears" is an impossible dwelling, for it will not draw properly and will certainly be filled with smoke a large part of the time. The experienced housewife will, if the tipi gets smoky on a gusty day, slip outside and with the skill of long practice, shift the direction of the ears a little. When a family shifts its quarters, the tipi is quickly struck, the cover rolled up, and two of the longest poles crossed like a V over the back of a pony, the ends trailing on the ground and constituting a travois. The family property, the cover, and the extra poles are loaded on the travois. Sometimes the tents of a whole village would be struck at the same instant, and in a few minutes each family would be loaded up, and the procession ready to start.

Not infrequently the earth was excavated a little in the center of the tipi and piled around the edge. Indians lived in such structures in the coldest weather, even in Dakota. Curiously enough, they are described as being on the whole warm and comfortable. The Indians have an animal sense for picking out suitable sites. There is many a spot in corners of the rolling plains country where, in the lee of a hill or tucked away under cover of the cottonwoods which border a creek, there is shelter from the full rigors of winter. In hard weather the great Indian encampments broke up, the families moving hither or thither, wherever they could find a favorable spot.

The distribution of this type of dwelling within the historical period was dependent upon the distribution of the buffalo. A whole tribe would sometimes hang on the flanks of a buffalo herd, moving as the herd moved. The horse had the effect of making the Plains Indians migratory and the consequent effect of enormously increasing the usefulness of the tipi. In more ancient times the Plains Indians undoubtedly ate buffalo meat, when they could get it, and undoubtedly had tipis. But the migratory way of living exclusively in tipis had not developed. We can glean some knowledge of the houses of that ancient period by excavation of old sites and through the fact that some tribes retained the older form of structure until recently. The characteristic habitation seems to have been a lodge, excavated in the ground, roofed with poles, and heaped over with earth, forming a sort of mound with the dwelling partly subterranean. This type of dwelling seems to have been distributed over a large part or all of western North America. It is therefore the next type of habitation to be examined.

The Underground House of Western North America

West of the 100th meridian, which marks the line between moist and arid regions, the habitations seem to be designed to give shelter from winds rather than from rain. There is along the Pacific coast, to be sure, from northern California to southern Alaska, a narrow strip with a reputation

for heavy precipitation. Although in parts of the strip, for example in southern Alaska, the precipitation is actually enormous, in a great part of it the rainfall is not really excessive. Portland, Ore., for example, has about the same annual rainfall as Washington, D. C. The strip offers a violent contrast, however, with the exceedingly arid lands to the eastward. Over the whole western side of the continent, wet and dry, we find habitations which may be classed under the general term "pit dwellings" for they all contain a central excavation. In the three geographic regions into which this western area may be divided, Plains, Plateau, and Pacific Slope, the size, shape, and materials of the house are greatly modified by local conditions.

The original type has been best preserved apparently on the Plateau. The tribes here are very conservative: their culture is backward in other matters than houses. We may begin, therefore, by looking at the underground houses of the Plateau, with the presumption that it represents an archaic type. It has spread from the Plateau proper down into certain areas in the central part of California, along with other elements of Plateau culture.

The first description of such houses was penned by Sir Francis Drake, who landed on the coast of California north of where San Francisco now stands in 1579. This place, now called Drake's Bay, he named New Albion. He describes the houses of the natives at this point as follows. "Their houses are digged round about with earth, and have from the uttermost brimmes of the circle clifts of wood set upon them, joyning close together at the toppe like a spire steeple. . . . Their bed is the ground . . . and lying about the house, they have the fire in the middest."[1]

The method of building these houses, as described by modern observers, may be outlined as follows. The earth is dug up and removed from a circular depression until a deep pit is formed. The sides of this pit are lined with timbers or slabs. Posts or supports are set up in the center, and beams extend from these center supports to the side walls, forming the framework of the roof. This roof is later covered in with poles, thatched with grass, and heaped over with earth. The entrance to the dwelling is through a hole at the top, which serves also as a chimney for the escape of smoke. Descent is effected by a ladder consisting of a half log, split lengthwise and having notches cut in it for placing the toes. Sometimes these houses are very large, giving accommodation to a number of families. The whole structure is substantial and solid.

The detailed construction of this house differs from tribe to tribe. It may be said, however, that this type of dwelling, including the entrance through the smoke hole, is found over a very large area in the interior of

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[1] The Course Which Sir Francis Drake Held from the Haven of Guatulco in the South Sea on the Backe Side of Nueva Espanna, to the North-west of California, etc. Reprinted in Richard Hakluyt: The Principal Navigations, Voyages, Traffiques, and Discoveries of the English Nation (12 vols., Glasgow and New York, 1903–1905), Vol. 9, pp. 319–326; reference on pp. 321.

FIG. 8

FIG. 9

FIG. 8—A village of "earth lodges" on the Plains, from a photograph taken among the Pawnee by W. H. Jackson, in 1871. This remarkable print shows the villagers gathered on the sides of their lodges watching some ceremonial performance in the center of the village. (After D. I. Bushnell, Jr., through the courtesy of the Bureau of American Ethnology.)

FIG. 9—The interior of an earth lodge, as portrayed by the Swiss painter Bodmer, who accompanied Maximilian, Prince of Wied, among the Plains Indians in 1833. The furnishings, paddle, weapons, carrying-frame, spoon of mountain-sheep horn, and costumes represent a period when these Indians were little influenced by the whites.

British Columbia, Washington, Oregon, and California—an area characterized by two things, aridity and the relatively low or simple culture of the tribes. The most characteristic forms are found perhaps among the Shushwap and Lillooet. The distribution of tribes which have, or have recently had, such houses is shown on Figure 10.

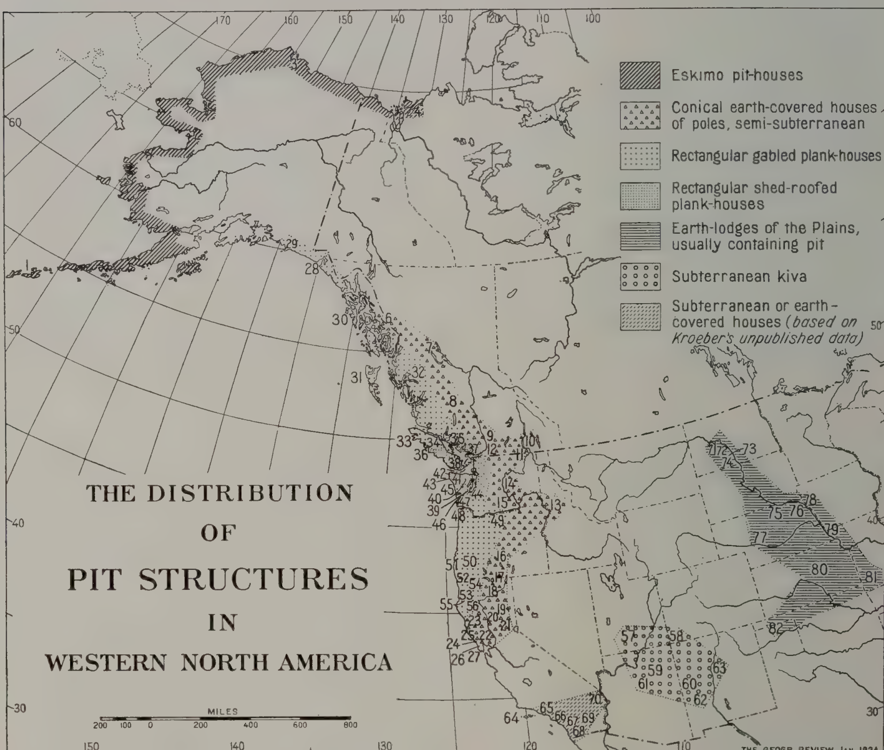

FIG. 10—Map showing the distribution of pit structures in western North America. (From T. T. Waterman and collaborators: Native Houses of Western North America (Indian Notes and Monographs), Museum of the American Indian, Heye Foundation, 1921.

Modified Forms of the Pit Dwelling: The Earth Lodge of the Plains

In near-by areas, where different conditions were encountered, the lodge became somewhat modified in form. For example, among most tribes on the Plains the pit became so shallow that the structures can hardly be described as pit dwellings. The general form was similar, but the space where the family lived was scarcely below the level of the ground, the excavation going down in some cases only one foot. In many localities, however, as in the houses reported from the Oto, Osage, Omaha, and Ponka, the pit was dug four or five feet deep. In some cases, as among the Pawnee and

Hidatsa, the houses were entered through the smoke hole. With the Hidatsa this happened only on "rare or special" (ceremonial?) occasions. There can be little doubt but that these earth lodges, widely distributed among the Plains tribes, were the same thing as the pit dwellings of the Plateau. The structures are always covered over with earth, so much so that they look almost like natural mounds, whence the common term "earth lodge." The sloping roofs of these dwellings, covered with turf, offered an ideal vantage point for observation. On the inside the lodges were roomy and quite comfortable and reported to be warm even in the most severe weather. The family life grouped itself around the fireplace in the center. After the introduction of horses, these animals were often stabled in one corner of the dwelling; this was the case, however, only with highly valued animals. The best and most commodious dwellings of this type were found perhaps among the Mandans, who at one time had very large villages on the upper Missouri. The Arikara and Pawnee also furnish good examples (see Fig. 8).

It is interesting to note that some ancient houses in this region are described as being entirely underground, being entered from above by a ladder. Thus, as we go back in the history of the region, the resemblance to the characteristic pit dwelling of the Plateau becomes more marked. Such old structures have recently been reported from eastern Nebraska, where they were excavated by Sterns,[2] and we have historical evidence that they formerly existed, for they were reported by an observer among the Pawnee in 1825, who saw them actually occupied.[3]

Underground Structures in the Southwest

In the southwestern United States we enter an area quite different geographically from the one we have been discussing. It has of course an even higher degree of aridity, the surface is excessively broken up, and human life would seem to be confronted by much more serious difficulties. Yet certain tribes here reached a much higher level of culture than the other tribes of North America. The native habitations here at the present time have little about them to suggest pit dwellings. On the contrary, they are quite lofty and pretentious structures sometimes four or five stories high. It is certain, however, that there were formerly pit dwellings in this area; and it is possible to trace the evolution of the modern pueblos from underground structures.

Several pieces of incontestable evidence point in this direction. In the first place, in the midst of the modern composite structures, which have square rooms and several stories, there are found certain ceremonial chambers, circular and subterranean, entered by a ladder through the roof. These are known by the native term *kiva* or the Spanish term *estufa*. The

[2] F. H. Sterns: Ancient Lodge Sites on the Missouri in Nebraska, *Amer. Anthropologist*, Vol. 16 (N. S.), 1914, pp. 135–137.

[3] W. E. Doyle: Indian Forts and Dwellings, *Ann. Rept., Smithsonian Instn. for 1876*, pp. 460–465; reference on p. 462

FIG. 11

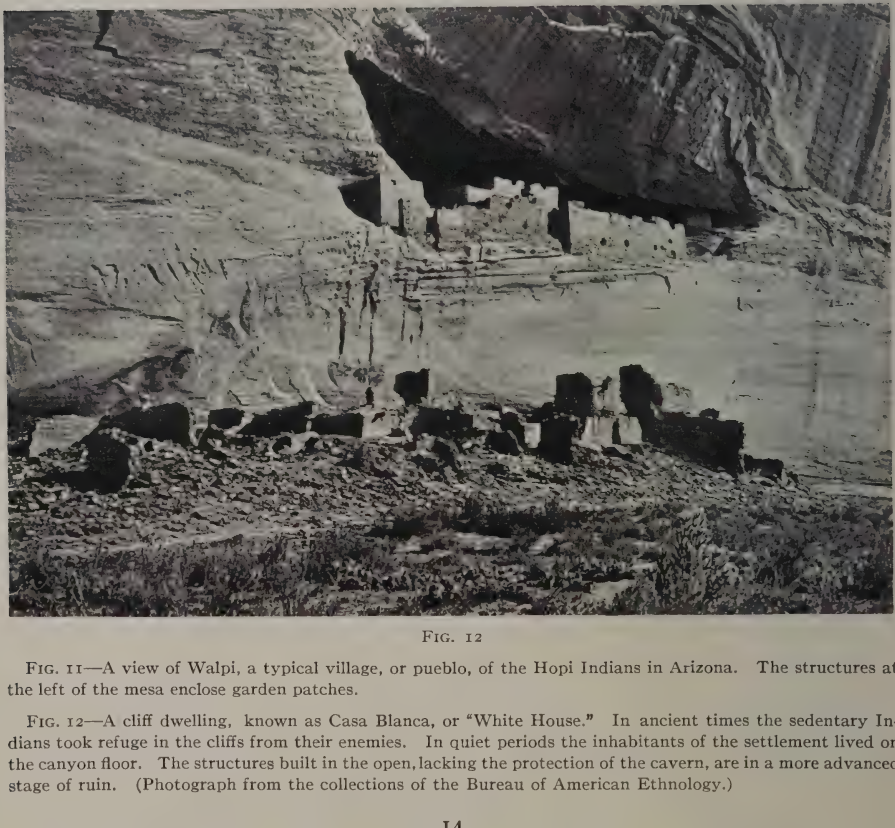

FIG. 12

FIG. 11—A view of Walpi, a typical village, or pueblo, of the Hopi Indians in Arizona. The structures at the left of the mesa enclose garden patches.

FIG. 12—A cliff dwelling, known as Casa Blanca, or "White House." In ancient times the sedentary Indians took refuge in the cliffs from their enemies. In quiet periods the inhabitants of the settlement lived on the canyon floor. The structures built in the open, lacking the protection of the cavern, are in a more advanced stage of ruin. (Photograph from the collections of the Bureau of American Ethnology.)

FIG. 13—The imposing walls of Pueblo Bonito, photographed after a snowstorm. This structure was a veritable fortress. None of the modern pueblos are so unified or compact. (Photograph from the collections of the Bureau of American Ethnology.)

reason for these underground chambers has always been a problem, though Cushing long ago suggested that the people may formerly have lived in underground houses but under later conditions preserved these chambers for religious ceremonies.[4]

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[4] F. H. Cushing: A Study of Pueblo Pottery as Illustrative of Zuñi Culture-Growth, *Ann. Rept. Bur. of Amer. Ethnology for 1882–83*, pp. 473–521; reference on p. 476.

This idea seems the more plausible when we consider the whole history of architecture in the region. It is a somewhat complicated matter, but certain stages may nevertheless be recognized. Beginning with the modern villages and going back we can recognize an architectural tendency towards greater compactness. At the time of the coming of the Spaniards the villages occupied better defensive positions than they do at present. When afraid of enemy attack the people moved their villages to the tops of the mesas. Some early structures which chanced not to occupy good defensive sites were very carefully planned for military strength. The finest example of this is the pre-Columbian structure known as Pueblo Bonito, an ancient site at the foot of a cliff in Chaco Canyon. This site has been intermittently under process of excavation for thirty years.[5] No modern village is so compact and well planned as this ruin. At a still earlier stage the village Indians often moved their towns bodily into a cave in the cliffs. It is unquestionably true that cliff dwellings represent a bygone stage in the history of these tribes. The cliff ruins, which have been well known for fifty years and often illustrated, contain the same square rooms and the same circular, subterranean ceremonial rooms and, it might be added, the same general types of pottery, stone implements, and ceremonial objects as the modern pueblos.

Recent excavators have brought to light a still earlier stage of culture preceding the cliff dwellers—that of the so-called "basket makers." Apparently before the southwestern tribes built the great composite clusters of square or rectangular structures which we call pueblos or cliff dwellings, they had small scattered structures, each family in a separate house. The houses, only scanty ruins of which have so far been brought to light, were apparently circular, subterranean, and entered through the roof.[6] These round houses represent the very beginning of masonry in this region, and the people were basket makers rather than potters.

The process by which isolated, circular, underground houses became square or rectangular chambers in aboveground structures is a little puzzling. According to Cushing it was not a replacement of one type of dwelling by a different type but a gradual modification. As the people became more successful farmers, they moved, Cushing thinks, into the cliffs for security for themselves and for the little stores of corn, about which they seem to have been even more concerned. The structures came to be built above ground because they could not be excavated in the rock of the cave floors. They became rectangular as the mere result of being crowded together in

[5] The National Geographic Society has exploration under way at Pueblo Bonito under Neil H. Judd of the Smithsonian Institution. See *Natl. Geogr. Mag.*, Vol. 39, 1921, pp. 637–643; Vol. 41, 1922, pp. 321–331; Vol. 44, 1923, pp. 99–108, and the Annual Reports of the Smithsonian Institution.

[6] M. R. F. and H. S. Colton: The Little-known Small House Ruins in the Coconino Forest, *Memoirs Amer. Anthropol. Assn.*, Vol. 5, 1918, pp. 101–126; reference on p. 126; Walter Hough: Exploration of a Pit House Village at Luna, New Mexico, *Proc. U. S. Natl. Museum*, Vol. 55, 1919, pp. 409–431; reference on p. 415; N. M., Judd: Archeological Investigations at Pueblo Bonito, New Mexico, *Smithsonian Misc. Colls.*, Vol. 74, No. 5, Washington, D. C., 1923, pp. 134–143; reference on p. 141.

FIG. 14—An Indian house on the northwest coast. The trees in this area are very large and easily split into planks. This habitation was erected without nails, saws, or any steel tools. The carvings on the splendid totem pole represent (above), three "watchers," and in order down the column Raven, Grizzly Bear, Beaver, and Grizzly Bear again. On occasions of ceremony, visitors enter *through* the pole. (From a photograph, made some years ago at the Indian village of Masset, Queen Charlotte Islands, B. C., in the collections of the U. S. National Museum.)

the limited confines of a cavern. For the same reason they came to be piled one upon another. Meanwhile the ceremonial chambers were made underground at any hazard, either by digging in or by building around and heaping over. Some kivas both ancient and modern are themselves rectangular, but the others seem to be much more characteristic.[7] Apparently we have in the exceedingly picturesque and interesting structures of the

[7] P. E. Goddard: Indians of the Southwest, *Amer. Museum of Nat. Hist. Handbook Ser.*, No. 2, New York, 1913, p. 30.

Southwestern Indians a progressive transformation of a very ancient, simple, and widespread type of dwelling which we have already traced in other areas.

Plank Houses of the Tribes of the Pacific Slope

On the western edge of the continent along the Pacific Ocean, in the narrow rainy belt already mentioned, the natives make houses that are outwardly as different from any of those we have been discussing as could

Fig. 15—An unusual photograph made many years ago showing the crude plank houses of the central Pacific coast region, near the mouth of Fraser River. The Indians here, belonging to the Salish stock, made blankets from *dog wool*. Certain dogs were bred for this purpose and were sheared like sheep, as described by the explorer Vancouver. Such dog-wool blankets are actually being worn by the people in the photograph. The author knows of no other photograph showing this kind of dog, which has become entirely extinct. (Photograph from the collections of the U. S. National Museum.)

well be imagined. The forest trees grow to a tremendous size, from eight to twelve feet in diameter. The wood is soft, and the logs split easily. The natives work the lumber up in various forms with the help of such primitive tools as stone adzes, mauls, and wedges of yew or antler. The houses in this entire region are made of plank.

The ordinary notion of Indian dwellings has to be quickly modified when we discuss the plank houses. In northern California, houses are intricate and rather ingenious structures put together with a considerable knowledge of carpentry, without nails of course. In size they are rather small, the largest measuring 18 by 30 feet. The houses of the Columbia River region are somewhat larger, measuring 25 by 75 feet. Farther north again in the

region of Puget Sound their size becomes surprising. H. A. Goldsborough, who went inside a house on the present Suquamish reservation in 1855 and measured all the principal beams, gives its length as 520 feet.[8] A reputable author, Simon Fraser, reports a house standing on the bank of the river now bearing his name, that was 646 feet long and 60 feet wide, saying particularly that it was all under one roof.[9] At the mouth of this river he saw a "fort" (whatever it may have been) 1500 feet long and 90 feet wide. Hill-Tout, whose statements are to be relied upon, says he has seen a house more than 1000 feet in length.[10] I have myself seen houses with roof beams

FIG. 16—Photograph showing the type of gabled house found among the Yurok of northern California. (After Waterman: Yurok Geography. From a photograph in the collections of the University of California.)

more than four feet in diameter; and, in other houses, wall planks more than five feet wide. The ruins of such gigantic plank houses are distributed from Humboldt Bay in northern California to southeastern Alaska. The most northerly examples I have been able to find in the literature are structures observed by Portlock in Prince William Sound, Alaska, in the year 1789. The main facts about these houses can be summed up by saying that they are always rectangular; are always made of split planks; and always contain in the center a pit or excavation in which the family lived.

[8] His measurements are quoted in George Gibbs: Tribes of Western Washington and Northwestern Oregon, *Contribs. to North Amer. Ethnology*, Vol. 1, U. S. Dept. of the Interior, Washington, D. C., 1877, pp. 157–241; reference on p. 215.

[9] Simon Fraser: Journal of a Voyage from the Rocky Mountains to the Pacific Coast, 1808 (Les bourgeois de la Compagnie du Nordouest; Récits de voyages, lettres, et rapports inédits relatifs au nord-ouest Canadien, Sér. 1), Quebec, 1889, p. 200.

[10] C. Hill-Tout: British North America, I: The Far West, the Home of the Salish and Déne (Series: The Native Races of the British Empire), London, 1907, p. 51.

When I first looked at the detailed construction of the plank houses in the various parts of this region I received an impression of great confusion. It seemed as if every tribe had a different type of dwelling, and some of them two or three. Boas long ago pointed out that the Haida and Tlingit have one type of house, with three roof beams on each side of the central line, while the Tsimshian and Kwakiutl have another type, with two such beams. To differences in size I have already made reference. The shape of the roof also differs markedly.[11]

When all the facts were plotted on a map, however, a certain amount of system appeared amid this medley. For example, over a tremendous extent

FIG. 17—Houses of the original Aleutian Islanders. The similarity to the earth lodges of the Plateau and the Plains is remarkable. Reproduced from James Cook: A Voyage to the Pacific Ocean, London, 1784.

of coast the houses are all of a gabled form, except in a small area about Puget Sound and the mouth of Fraser River where they have a flat or "shed" roof, with a single pitch in place of the gable. In the case of the gabled houses the end of the house is toward the beach; in the case of the flat-roofed house one long side of the structure parallels the beach. In the north and the south there is characteristically one entrance. In the central area there is often a series of openings along the front side with the addition of at least one opening in the rear and still other openings in the ends. The houses of the central area are also of simpler construction. In connection, too, with all gabled houses there is a curious way of giving every house a name. This is not true of the flat-roofed houses. Among the Yurok the names of houses are mostly commonplace. They include such expressions as "at the end of the row," "near the creek," "in the middle," "above the

[11] T. T. Waterman and Ruth Greiner: Indian Houses of Puget Sound (Indian Notes and Monographs), Museum of the Amer. Indian, Heye Foundation, New York, 1921.

others," "in rear of the village," "set away from the river," "facing the ocean," and other simple descriptive names. I have given elsewhere a list of these Yurok house names.[12] Some of them are a little more ambitious. We find occasionally such names as "big house," "biggest house," "house of feather-plume trees," "where they dance," "where there is sound of dancing." Among the Yurok the thing has taken such a peculiar turn that personal names are supplanted by descriptive expressions based on the names of houses. I have not heard of such a custom in any other part of the world. On the northern Pacific coast, the names of houses are wonderfully high-sounding. Often they refer to the totem crests of the owners. Some houses

FIG. 18—Interior of the Aleutian earth lodge shown in Figure 17.

that I have been in myself are "Eagle leg house," "Black-bear house," "Wolf house," and "Killer-whale house." Such names as "Sun house," "Daylight house," "Darkness house," "Moonlight house," "Mountain house," or "Thunder house" indicate the owner's high rank. The names just given are Tlingit from southeastern Alaska. Swanton reports a Haida who had a house so grand that he called it by a name signifying that clouds moving across the sky knocked against it.

The fact that at the northern and southern limits of the region the houses have names certainly suggests a former connection. It is my opinion that the gabled plank houses represent a diffusion up and down the coast. As we go toward the center the size increases: at the ends of the region are similarities of form, though the use of totem poles in the north gives a different atmosphere externally. In the case of all gabled houses the gable end is toward the beach. It is a fair presumption that the flat-roofed houses of

[12] T. T. Waterman: Yurok Geography, *Univ. of California Publs. in Amer. Archaeol. and Ethnol.*, Vol. 16, 1920, p. 208.

FIG. 19

FIG. 20

FIG. 19—A Navajo "hogan," a conical earth-covered dwelling. (From a photograph by George Wharton James in the collections of the Bureau of American Ethnology.)

FIG. 20—A wind break erected by the Papago Indians of the Arizona desert. The Seri, living on the Gulf of California south of the Papago, are said to have no roofed structures: the country is practically rainless, and they seek shelter only from the wind. (Photograph from the collections of the Bureau of American Ethnology.)

the Fraser River region represent a later form, possibly brought in with the less highly cultured Salish tribes which have overrun this region. The gabled form would appear to be the older, and its distribution was probably con-

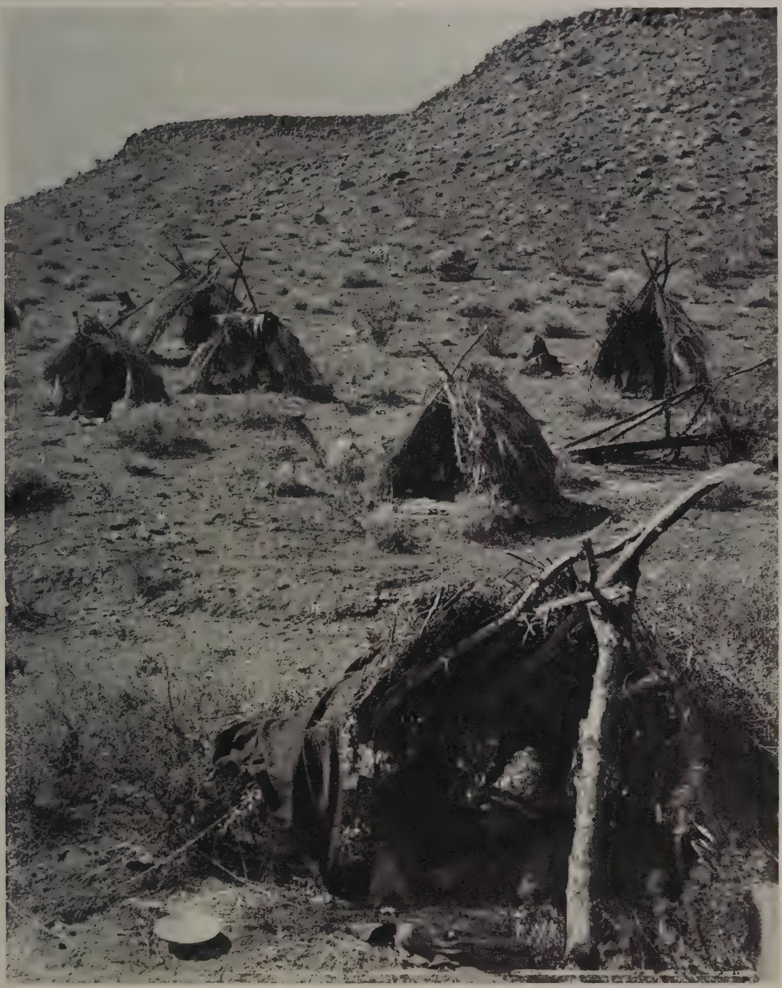

FIG. 21—The simple life. A "village" of Paiute wickiups on the plateau of Nevada. These structures may safely be regarded as near the bottom in the evolution of houses.

tinuous along the coast at some former period. This appears rather clearly from the map.

The dwelling house in northern California, made of planks split from the redwood tree, was quite a tidy structure. Inside the house a pit was dug, four or five feet deep, in which the inmates lived. Around on a sort of earthen shelf, between the edge of the pit and the walls, was a space for storing things—baskets full of acorns, piles of dried fish and eels, furs, pelts, bows, a thousand varieties of miscellaneous property. A person descended to the bottom of the pit by means of a short ladder of notches in a log. A

fire, of course, burned in the center of the pit; and on racks overhead there was usually fish or deer meat in process of preservation. The men were not allowed to sleep within this house. At nightfall all males, young and old, were obliged to go to certain special structures known as sweat houses. These were underground chambers carefully closed up and almost air-tight. The only time that families were together was during a season in the spring and summer when the Indians scattered, camping along the river and fishing for salmon.

The houses in Alaska were from 40 to 70 feet broad and sometimes 80 or 100 feet long, and I have seen in a ruin a house pit more than eight feet deep. Though they did not rival in size the prodigious habitations around Puget Sound, the Alaskan houses were much more elaborate, as might be expected from the fact that these Indians had a more advanced culture. They are made even more interesting by the presence of numerous totemic carvings. The most conspicuous of these are gigantic columns known as totem poles. Totemic symbols are carved not only on the totem pole but on the house, inside and out, and on canoes, boxes, dishes, spoons, and a great variety of objects.

That all the rectangular plank houses have pits is a curious thing indeed. It is difficult to see in what way they are advantageous. Furthermore, the rectangular plank structures containing pits are distributed along the margin of an area where genuine pit dwellings exist, i. e. in which the pits are a vital part of the house construction. The simplest explanation would seem to be that the rectangular plank houses represent the transformation of the old conical earth-covered pit dwellings made of poles, in an area where the growth of giant spruces and cedars made the production of wide boards or planks possible and fairly easy, and the form almost inevitably became rectangular. On the Plateau suitable timber does not exist. The coast people have never been able, however, to get away from the idea of the central pit.

Eskimo Houses

The Eskimo have two forms of winter habitation, the snow house, built when they are encamped on sea ice, and also a form of underground house. Construction of the latter differs widely in the eastern and western parts of the Eskimo area, for in the east the Eskimo is almost entirely without wood. In Greenland, in Labrador, on the shores of Hudson Bay, and westward beyond Boothia Felix it is made of crude masonry. A pit is dug, and the walls are carried upward with course after course of stone. When flat slabs are obtainable the successive courses project inward, from which it would seem that the Eskimo is trying in a crude way to fashion his roof into an arch or dome. Material for roofing is often hard to find; jawbones of whales are commonly used for the purpose. The house is below the level of the ground; and in summer, when the snows melt, it fills up with water. Then the Eskimo moves out and camps in a tent until winter comes again.

On the western side of Arctic America timber is found in great quantities. Even where trees are scarce large quantities may be obtained as driftwood along the coast. Here the house is as nearly as possible a replica of the earth lodges of the distant Plateau.

The use of underground houses by the Eskimo forms a link between America and Asia. In northeastern Asia underground habitations are in constant use, for example, among the Koryak, Chukchi, and Kamchadal. Such pit dwellings have also been reported from Sakhalin Island, from Japan, and from farther afield. It would seem possible that all the underground and semi-underground houses which have been described have been derived at some ancient time from Asia.

Puzzling Types of Houses

The Pima use a type of dwelling called the *kee*. It is circular in form, made of wattle, and plastered with clay. It contains no pit. Where they got the plan of this house is very much of a puzzle. The Navajo build a conical type of house which they call the *hogan*. The framework consists of three poles, which strongly indicates relationship with the tipi of the Plains. The center of the house is excavated down into the ground, and the whole is heaped over with a thick covering of earth; both of which features suggest the earth lodge. The crudest habitation in North America is undoubtedly the wikiup of the Paiute, a brush shelter. Finally there is one tribe of North America, the Seri of Tiburon Island in the Gulf of California, who do not know how to make houses at all. The best they can achieve is a wind break. They live, to be sure, in an all-but-rainless area.

Relation to Mexican and Central American Architecture

The houses of the Indians of southern Mexico and Central America, to say nothing of the structures of Bolivia and Peru, lead us into another horizon altogether. In these regions the Indian became a real architect. Some of the most imposing stone structures ever raised by the hand of man are to be found in these areas. The pyramids found in Mexico at Papantla, Cholula, and Teotihuacan, recently excavated by the Mexican Government through Dr. Manuel Gamio, actually rival the pyramids of Egypt in size and interest. Great numbers of ruined cities are gradually being brought to light, some of them in the most romantic surroundings. It is worth remembering that the American Indian in certain localities rose by his own unaided efforts to the production of a great architecture, of which the simpler edifices we have been discussing represent the beginnings.

THE EVOLUTION OF LAPIÉS

A STUDY IN KARST PHYSIOGRAPHY

By Jovan Cvijić
University of Belgrade

Certain parts of the Dinaric karst lands offer extraordinary difficulties of transit. These are the regions of *lapiés*, surfaces covered by a network of furrows and crests, well avoided by man and beast.[1] If the traveler's foot slip into one of the narrow furrows he may experience considerable difficulty in extricating it. Or his guide may select an inopportune moment to vanish behind the ridges. The shepherds of the lapiés country suffer not infrequent loss of animals caught in the furrows and become the prey of wolves.

Lapiés are developed on surfaces of pure limestone and, as we have indicated, consist of narrow channels, or furrows, between which are ridges or crests, most often sharp, less frequently rounded in contour. The channels usually range from about 1½ to 3 feet (0.5 to 1 meter) in depth but now and then reach 6 to 10 feet (2 to 3 meters) and even 16 to 20 feet (5 to 6 meters); exceptionally there are lapiés channels which are 30 to 40 feet (10 to 12 meters) deep. If the ridges are broad, they are often furrowed by secondary, shallow channels. Sometimes the channeling is quite regular: sometimes there are also chaotic lapiés, a medley of channels and ridges.

Lapiés correspond to those minor forms which in other terrains are the result primarily of mechanical denudation. In the roughness and inaccessibility of the terrain they are similar to the "bad lands" developed on clays and sands. But the formation of lapiés is due chiefly to chemical erosion. The forms, furthermore, are much longer lived than those of the "bad lands;" but, nevertheless, the same process of destruction which is characteristic of the latter and other minor erosive forms is also a feature of lapiés. The deeper the channels become, the sharper, more pointed, and thinner are the ridges; so that at last they break and crumble to bizarre-shaped pieces.

Recognition of Lapiés as a Karst Form

It was as far back as 1893 that appreciation of the association of lapiés proper with limestone led to the classification of the lapiés as karst forms.[2]

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[1] Cf. the review of the author's paper "Hydrographie souterraine et évolution morphologique du Karst" (*Recueil des Travaux de l'Inst. de Géogr. Alpine,* Vol. 6, 1918, pp. 375–426) by E. M. Sanders: The Cycle of Erosion in a Karst Region, *Geogr. Rev.*, Vol. 11, 1921, pp. 593–604.

[2] Jovan Cvijić: Das Karstphänomen (Geogr. Abhandlungen von A. Penck, Vol. 5, No. 3), Leipzig 1893. The whole literature published on the subject of lapiés up to that time is quoted. Accordingly, I shall here cite only the more important works which have appeared since 1893. Much attention is paid to works on lapiés published up to 1907 in Hans Hilpert: Die historische Entwickelung der Frage nach dem Wesen des Karstphänomens, Würzburg, 1907; and see also Max Eckert: Das Gottesackerplateau, *Wissenschaftl. Ergänshungshefte zur Zeitschr. der Deutsch. und Oesterr. Alpenvereins,* Vol. 1, No. 3, Innsbruck, 1902.

They are not, however, developed in all limestones; if the beds be thin and laminated, they weather into laminae or plates, on which no lapiés are formed. Dolomite also weathers in a similar way, so that small forms resembling lapiés occur only here and there. They also occur sporadically in rocks containing calcium carbonate in other forms. The rare forms seen in granite, gneiss, and sandstone, which have been more than once referred to as lapiés, merely simulate the normal lapiés. Nor do they occur in terrains consisting of salt and gypsum. Lapiés are in fact peculiar to the karst, being associated with various karst surfaces but especially those constituted by pure limestone beds of considerable thickness or of limestone conglomerate with a limestone cement.

Vertical Extension of Lapiés and Connection with Other Karst Forms

Lapiés are found at all altitudes from sea level to lofty mountain summits. They were first observed and described in the limestone Alps in Switzerland, where in the cantons of German speech they are called *Karren* or *Schratten* and in districts of French speech *lapiéz* or *lapiaz* or *lapiés*, then *rascles*, *esserts*, and, in the Jura, *laissines*. Hence they were often causally associated with snow and glaciers. Some of the investigators even held that lapiés were the work of the grooving, furrowing action of glaciers. Such an action is now known to be impossible as a cause of lapiés. Even if they could be formed under some cavity in the glacier where water drips down upon the limestone from the glacier roof, they would nevertheless be destroyed by the forward motion of the glacier itself. However, streams from the melted snow and ice can hollow out deep lapiés; and, furthermore, extensive areas of such lapiés occur where the rainfall is great. Accordingly, lapiés are frequently and typically developed in the Alps and especially in proximity to glaciers. Investigations have also proved that lapiés channels are often of postglacial age because they occur on the smoothed and polished limestone surfaces over which ancient glaciers have passed.

In the Alps lapiés occur on the Parmelan, south of Geneva, and particularly in the Désert de Platé and other mountains of Savoie (Pointe Percée, Rocheurs de Leschaux, and Cornette de Bise). The tract of lapiés in the Désert de Platé occupies an area of about 15 square kilometers, and the lapiés are met with from a height of 1850 meters up to 2350 meters. The lapiés on Silbern, in the canton of Schwyz, have long been known; this tract is about 60 square kilometers in extent and lies between 1500 and 2500 meters in altitude. These lapiés are in Lower Cretaceous limestone, which on this account has been named the Schrattenkalk.[3] There are other varieties in the Wallensee region, on Säntis and the Tannenalp in Switzerland. The deepest

[3] Émile Chaix: Contribution à l'étude des lapiés: La topographie du Désert de Platé, *Le Globe*, Vol. 34, 1894–95, Mémoires, pp. 67–108, Soc. de Géogr. de Genève, Geneva, 1895; *idem:* Contribution à l'étude des lapiés: Le Silbern (Canton de Schwytz), *ibid.*, Vol. 44, 1904–05, Mémoires, pp. 49–60, Geneva, 1905; Émile and André Chaix: Contribution à l'étude des lapiés en Carniole et au Steinernes Meer, *ibid.*, Vol. 46, 1906–07, Mémoires, pp. 17–53, Geneva, 1907.

FIG. 1

FIG. 2

FIG. 1—Young lapiés on the outcrops of limestone beds. Prenj.

FIG. 2—Young lapiés of honeycomb form, with a transverse fissure. Velebit, 100 meters above the Adriatic Sea.

Fig. 3

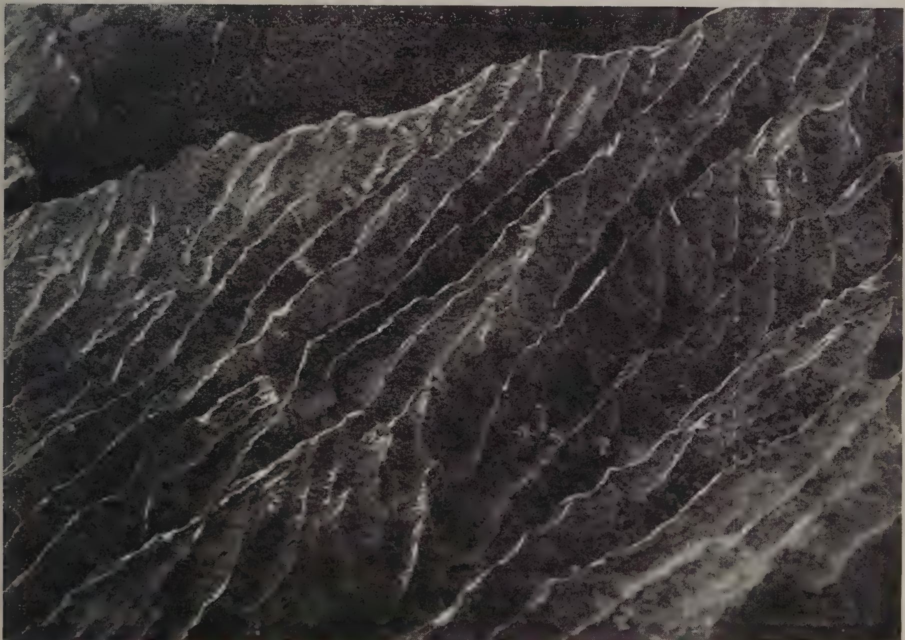


Fig. 4

Fig. 3—Young lapiés; deeper only on the outcrops of beds. Lučin, Prenj.

Fig. 4—Young lapiés having the form of furrows. On the coast of the Quarnero Channel near Maslenitsa, 10 meters above the sea.

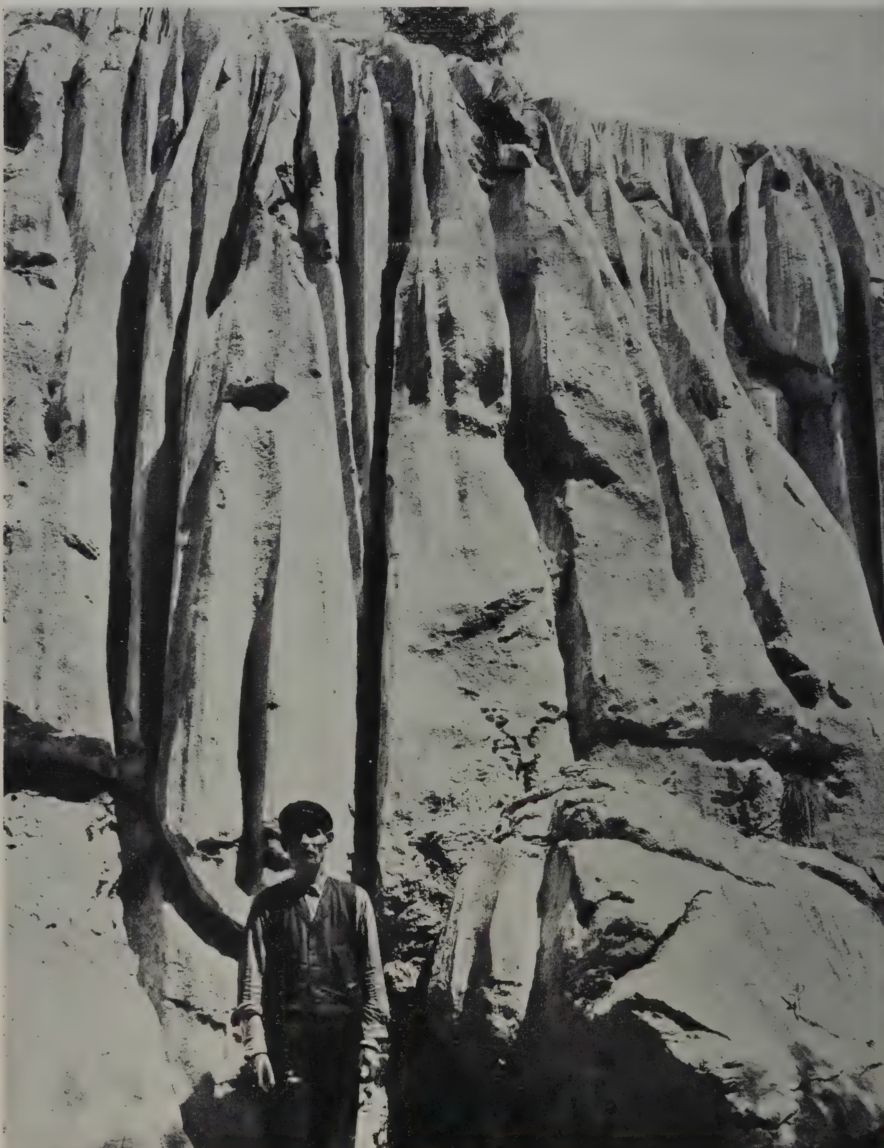


FIG. 5—Young lapiés in the form of passages and gashes. Hajdučki Kuk, Velebit.

and most typical are in the Schrattenkalk of Mattstock at the height of 1600–2000 meters, on Säntis at the height of 2050 meters. A development of chaotic lapiés is found in the Malm (Upper Jurassic) limestone at heights of 1850 and 2160 meters. They are less well developed in the Seewerkalk facies of Turonian age (Upper Cretaceous) in the western Alps, although on the surface of strata dipping at about 20° and at the height of 1700 meters

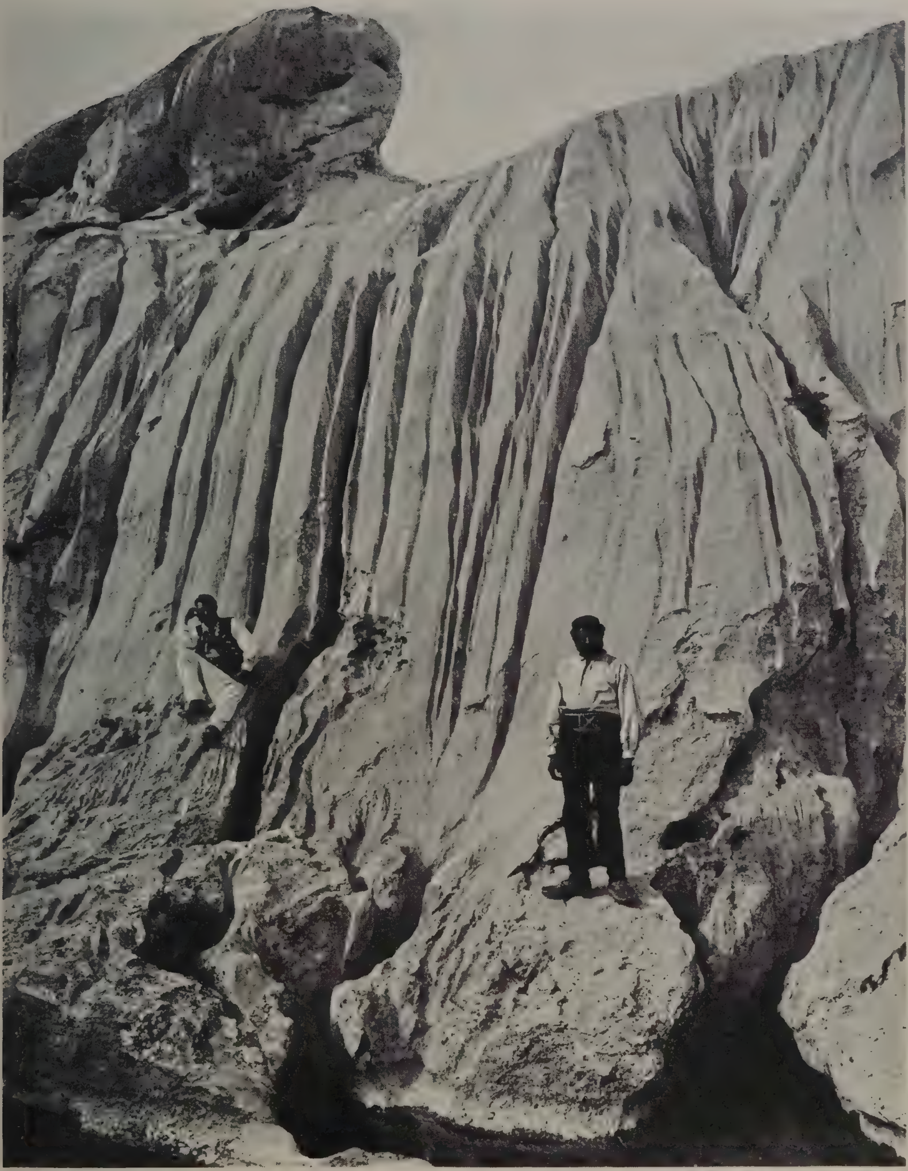


FIG. 6—Deep lapiés on a steep slope. Prosinac, near Obrovac, Dalmatia.

there is a typical lapiés area, with channels 10–20 centimeters wide and about two meters deep. In the part of the Axenstein Hotel, near Brunnen, at the height of 700 meters is a lapiés area with rounded ridges, which in the opinion of those who have investigated it was formed during the recession of the glaciers of the Bühl-Gschnitz stage.[4]

[4] Arnold Heim and Paul Arbenz: Karrenbildungen in den Schweizer Alpen, *Geol. Charakterbilder herausgegeben von H. Stille*, No. 10, Berlin, 1912.

Lapiés are particularly well developed on the Gottesackerplateau of the Hoher Ifen, in the Algau Alps, where they have been studied with care by Eckert.[5] The lapiés areas in the Steinernes Meer, in the eastern Alps, covering some 10 kilometers in length and 3 kilometers in breadth at an elevation of 2100 meters, have been known for a long time. With these might be mentioned the lapiés area on the Übergossene Alp, 5 kilometers in length and 2 in breadth. Lapiés are met with on the Dachstein,[6] in the Rax-Alpe, in the Carnic Alps,[7] and in other parts of the eastern limestone Alps.

But the terrain where lapiés are best and most extensively developed is the Dinaric karst, stretching from Trieste in the north to Scutari in the south. They occur there in all limestones from the Triassic to the Paleogene. They have been observed on the shore of the Adriatic Sea and on the highest mountain peaks of 2500–2600 meters. Lapiés, in fact, constitute one of the main features in the physiognomy of this bare, rugged, and desolate country. Stache was one of the first to observe them on the western coast of Istria, and he attributed their origin to the action of sea waves and further drew the conclusion that all other lapiés of the Adriatic karst, including those of higher altitudes, had been formed by the action of the waves of ancient seas.[8] As a matter of fact, many of the forms from here which have been described as lapiés are not lapiés at all. I have not observed normal lapiés anywhere on the western coast of Istria. The formations in Val-Saline near Pola, which Émile Chaix photographed, are probably not lapiés, an opinion in which Chaix himself concurs. I have noted true lapiés, in those parts of the Adriatic coast which are composed of pure limestone e.g. on Lapad, near Ragusa, and on the Quarnero side of the Velebit. They have been formed by the action of wave water streaming back to the sea and by the showers of breaking surf. Formation under these conditions is bound to be rare, for wave action is more likely to destroy those lapiés which had been formed by the action of atmospheric water. Boblé has observed normal lapiés in several places of the Peloponnesus coast. They are found also on the southern shore of the island of Ithaca and on Cephalonia, where along the shore there is often a belt of lapiés 6–8 meters wide, the surface of which is covered with a black incrustation.

Mojsisović[9] believed the alpine lapiés to be forms corresponding to the dolines or sinks, as numerous in the limestone regions of the Adriatic as the lapiés in the Alps, and concluded that where lapiés are developed there will be found no dolines. But now it is well known that both lapiés and dolines occur in the alpine limestone regions as well as in the entire Mediterranean

[5] Eckert, *op. cit.*

[6] Friedrich Simony: Über die Spuren der vorgeschichtlicher Gletscherausdehnung im Salzkammergute *Berichte über die Mitth. von Freunden der Naturwiss. in Wien*, Vol. 1, 1847, pp. 215–247.

[7] Michele Gortani: Fenomeni carsici nei terreni paleozoici della Carnia orientale, *Mondo Sotteraneo*, Vol. 5 No. 3–5, Udine, 1909.

[8] Guido Stache: Die librunische Stufe und deren Grenzhorizonte, *Abhandl. Geol. Reichsanstalt* [*zu Wien*]. Vol. 13, No. 1, p. 14.

[9] V. Mojsisović: Grundlinien der Geologie von Bosnien-Herzegovina, p. 226.

karst. Moreover, lapiés are often found on the sides of dolines. Thus, the northwestern sides of the uvalas (coves) Igrište and Torovište of Kučaj, in eastern Serbia, sloping at 30°–40°, are covered by lapiés, with channels as much as a meter deep. Lapiés are also associated with sinks on Devica and Suva Planina (the Dry Mountain) in Serbia. In the Pass of Duga in Montenegro the northern and western sides of the sinks exhibit lapiés, particularly round the fort of Nozdra in Duga. I have also observed lapiés on the sides of sinks on the border of Gacko polje (Hercegovina) as well as near Zadvorje in Dalmatia. According to Dr. R. Simonović they are also to be seen in the dolines on Velebit.[10] Nor are such examples limited to the Dinaric karst. For example, on the Dachstein in the eastern Alps I have seen a number of sinks whose southwestern sides were covered by typical lapiés. The association of lapiés with sinks is also to be met with on the Todtes Gebirge and on the plateau of Steinernes Meer and in the Berchtesgaden Mountains. Dr. Absolon has remarked sinks with lapiés even in so mild a karst development as that in Moravia north of Brünn.[11]

Lapiés, therefore, are not limited to the Alps and other regions characterized by the existence of present or former glaciers; on the uplands of the Dinaric karst they have not been formed by the action of sea waves in former times; neither are they a form equivalent to the sinks of limestone terrains without the Alps—as the first limited observations of lapiés led various observers to conclude. It was not until lapiés had been studied in many regions and at different altitudes that their origin and evolution could be rightly traced. Before we take this up, however, we shall briefly describe various kinds of lapiés.

Various Forms of Lapiés

The forms of lapiés are numberless and so varied that we cannot imagine even the most bizarre form which is not to be found among them. Thus we shall select for description only a few of the principal forms or groups—according to their degree of development or their connection with joints or bedding planes and ponor lapiés.[12]

Initial forms of lapiés are to be met with most frequently. The ridges are hardly discernible; and only in places where the limestone is most pure or along fissures are there any deeper furrows. Then come lapiés with more numerous and deeper furrows and with larger passages and holes in the rock. This variety is met with on the outcrops of recently uncovered limestone beds. In Velebit lapiés of this type are known as *muzgas*. To initial forms of lapiés belong also those possessing a reticular or honeycombed structure. Normal young lapiés have shallow channels and sharp ridges; they resemble gullies cut in clay or sands after a shower of rain. They appear characteristi-

[10] Radivoj Simonović: O škrapama [On lapiés], *Bull. Soc. de Géogr. de Belgrade*, Vol. 5, 1921, pp. 142–159.

[11] K. Absolon: Führer durch die Macocha und die neuen Tropfsteingrotten, Punkwa- und Katharinen-Höhle, Brünn, 1920.

[12] Ponor, or *gouffre d'absorption*, is the shaft or abyss by which a stream in a limestone region is swallowed up to flow underground.

FIG. 7

FIG. 8

FIG. 7—Parallel lapiés furrows, which continue beyond a horizontal joint. Čvrsnitsa, about 1500 meters altitude.

FIG. 8—Parallel lapiés channels in developed lapiés. Prenj, about 1600 meters altitude.

cally on very steep slopes as parallel channels 2–3 decimeters deep. Of particular interest are the finely chiseled lapiés, whose slope conforms with that of the surface upon which they are developed and among which larger depressions have begun to form in places. In other cases, along the shallow lapiés furrows and crosswise upon them and upon the surface slope, occur short lapiés passages, following fissures and still undeveloped. Across glacially smoothed surfaces postglacial lapiés are seen along fissures, with direction either conforming to that of the surface slope or transverse upon it.

In a further stage of development occur lapiés which are deeper than the foregoing. The rocks are cut into as by a knife, the channels often being 1–2 meters deep; while on the ridges appear shallow depressions and furrows which remind one of the lapiés of the preceding class. The diverse forms are dependent upon the texture of the limestone. Some with deep but narrow passages have sharp edges, while the surfaces of the ridges are faintly chiseled (lapiés at Prenj). Others still more deeply furrowed, their channels 3–4 meters deep, remind one of the multifarious branching of river valleys or of "bad lands" topography (Lupoglav in Krivošije, Bocche di Cattaro). Still others represent a class of chaotic lapiés known in Serbian as *škripovi*, the channels of which show broadenings and depressions of irregular form (Vaganac, Velebit). Thus on the ridges and also in the channels there may be flat-bottomed or trough-like hollows, *kamenitsas* in Serbian, in which atmospheric water remains a long time, especially if the hollow is roofed over by a block of stone. The largest *kamenitsas* are in Prosine, near the town of Obrovac in Dalmatia, at one of which are watered the cattle of ten households.

In the lapiés areas of karst uplands there are certain special forms. Thus, every rock on the platform of Cvrsnitsa, in Hercegovina, is perforated through and through, as are also the ridges between the deep lapiés channels. There also lapiés wells are characteristic forms. The mouth is circular or elliptical in form, of 2–3 centimeters to 2–3 meters in diameter, while the maximum depth is 20 meters. Lapiés wells occur in many parts of the Dinaric karst, and on the Gottesackerplateau, while they are particularly numerous in the Désert de Platé and on Parmelan in Savoie where they are sometimes 4–8 meters in diameter. They are not to be confused with the hollows known as *kamenitsas*. Well-like dolines of small diameter are also found among lapiés and represent nothing more than the widened lapiés wells. Sometimes the well-like dolines are developed into funnel-shaped sinks, 5–6 meters in diameter. And, again, among the lapiés channels there are some, 4–5 meters wide and several meters long, which are closed at both ends and thus represent a kind of elongated doline. This does not mean, however, that all the numerous well-like and funnel-shaped dolines of karst terrains have been formed out of lapiés; on the contrary, such cases are rare.

In the high Dinaric karst among the lapiés are forms known in Serbian as *strugas*. Initially they are passages cut along the bedding planes and are commonly some 1–2 meters wide and several meters long and open at both

FIG. 11

FIG. 12

FIG. 11—Lapiés wells. Velebit.

FIG. 12—A *struga* (S) and a doline (V) in lapiés. Bojinac, Velebit.

FIG. 13

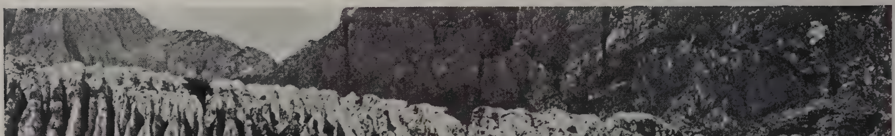


FIG. 14

FIG. 13—Lapiés of a normal slope and fissure lapiés crosswise upon the slope of the side. Maslenitsa, Quarnero Channel.

FIG. 14—Normal lapiés whose continuity is broken by a deep lapiés passage formed along a fissure that is transverse upon the slope of the sides. Prenj, about 1600 meters altitude.

FIG. 15

FIG. 16

FIG. 15—Deep channels with lapiés stones and between rounded ridges. Lubenovac, Velebit.

FIG. 16—Lapiés along bedding planes. Mosor, Dalmatia.

ends, the sides being inclined or vertical according to the dip of the beds. They may be wider and much longer, as the photograph from Velebit shows. There are cases where *strugas* join two dolines or uvalas. They are formed out of lapiés channels, especially when these develop along joints.

Lastly there are the *yamas*, perpendicular or oblique shafts, which at a greater or less depth lead into caves. The *yamas* are not always lapiés forms. In general they belong to the older, pre-lapiés surface and were developed under different hydrographic conditions. Before lapiésation had commenced the karst terrain was traversed by normal valleys, whose rivers disappeared in ponors. *Yamas* are usually the relics of ancient ponors but not infrequently are formed simultaneously with the lapiés.

In some regions lapiés frequently develop along fissures, as in the Désert de Platé, in the Gottesackerplateau, and the Dinaric karst. They are either channels of broken continuity along a simple fissure, or continuous passages along several crossing fissures, or long but narrow channels along faults. Sometimes, as on Prenj, along the fissures crosswise upon the surface slope there are lapiés wells and passages which interrupt the normal course of the channels. Near Lubenovac, Velebit, deep channels with rounded ridges between are developed in fissures. In the Désert de Platé is often seen a complex of short channels associated with a whole system of fissures running in different directions. Of different appearance are lapiés which accompany bedding planes, as is seen from the photographs, Figures 16 and 17.

Lapiés on the ponors of karst rivers and especially in karst poljes constitute a special class. The ridges are rounded, and between are deep passages and *yamas* (*avens*, or chasms). On the ponor lapiés in Dvrsno (Krivošije, Bocche di Cattaro), besides such ridges and *yamas*, there are notches and passages, formed by the action of meteoric water.

Lapiés in forests and bushwood are different from all the preceding. Their ridges are rounded and broad; and the channels are usually rugged.

The Origin of Lapiés

Influence of Rock Composition and Texture

From what has been said it can readily be concluded that lapiés are formed principally by chemical erosion of limestone surfaces by meteoric water. By solution of the limestone the stream water deepens the channel. The greater the rainfall and the longer the surface is exposed, the deeper and larger will the lapiés become. The direction of stream flow and consequent chemical erosion of the channel is influenced by the composition of the different limestone zones and the rock texture. The composition of the limestone often changes from square foot to square foot: there occur argillaceous bands, fragments of chert and fossils, amorphous masses and lumps permeated with hematite, etc. All such constitute obstacles round which the stream of water curves seeking the lines of purer composition. In the case of water

Fig. 17

Fig. 18

Fig. 17—Lapiés along vertical beds. Tulove Grede, Velebit.

Fig. 18—Coarse lapiés in a limestone breccia in whose channels there is vegetation. Sugarske Dulibe, Velebit.

derived from melted ice and snow as compared with meteoric water, the action is reinforced by greater continuity. In purely homogeneous limestone, lapiés are distinguished by smooth depressions between which are sharp edges, while in unhomogeneous limestones the depressions are rugged and usually more irregular. As has already been mentioned, streams and spray of sea water can also produce lapiés. Under certain conditions mechanical erosion has some influence on the sculpturing of lapiés. For instance, water left behind in a depression or fissure and frozen shatters the limestone at the bottom of the channel. The deeper a lapiés well is, the more meteoric water

FIG. 19—A wide *struga* in destroyed lapiés. Alančić, Velebit

discharges over its brink, so that later it is also deepened mechanically. Channels in argillaceous bands in the limestone may be deepened mechanically by water streams. Mechanical erosion cannot be completely omitted from discussion of the formation of lapiés.

Influence of Fissures

Fissures undoubtedly have considerable influence on the formation of lapiés, and, since every limestone is not equally fissured, the influence of this factor also differs in different terrains.

It is natural that a stream of water coming upon a fissure dissolves the limestone along it and deepens the channel. Here again the effect of rock composition appears: along fissures there occur discontinuous channels or lapiés passages, separated one from another by the more resistant bands of

limestone. When several fissures meet at a point, or cross one another, the work of chemical erosion is here intensified, and at such points a lapiés well is formed. It may be noted parenthetically that a lapiés well may be formed also without the aid of fissuring by the chemical dissolution of a body of limestone which is purer than the neighboring mass.

Fissures that cross a sloping surface transversely give rise to lapiés also transverse to the surface slope. Again there are sometimes to be seen groups

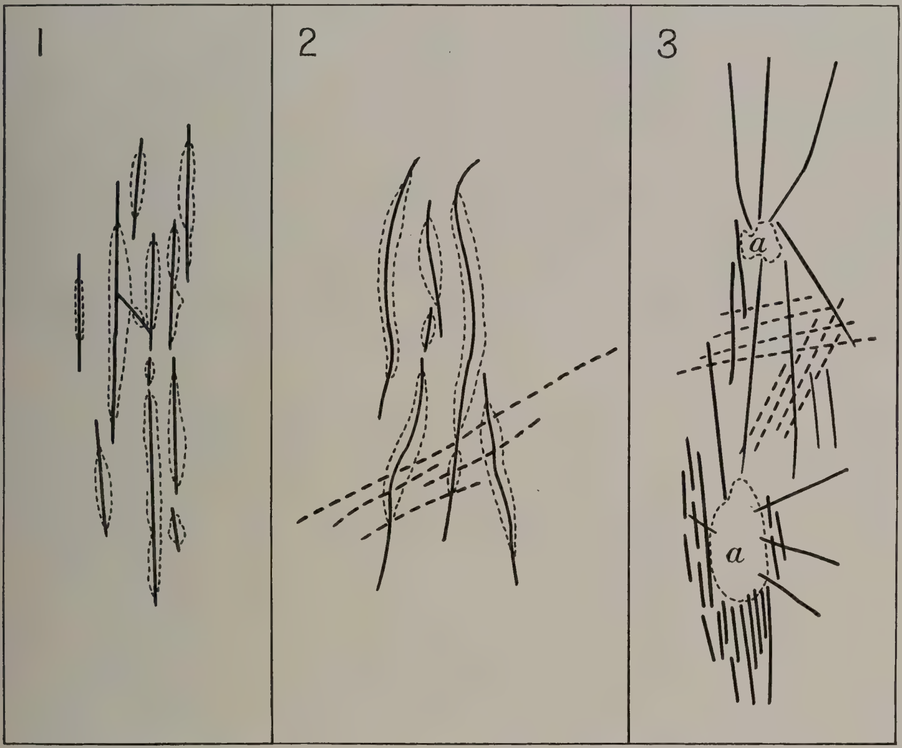


FIG. 20—Influence of fissuring on lapiés development. No. 1 shows lapiés channels along parallel fissures; No. 2, lapiés along winding but parallel fissures; No. 3, lapiés wells (a) at the meeting point or the crossing of fissures. Heavy broken lines indicate fissures filled with calcite. From examples in the Désert de Platé.

of parallel fissures along which parallel lapiés passages are hollowed out. Sometimes the fissures are winding, and in that case parallel but winding lapiés channels are formed. Examples are to be found in the Dinaric karst, and there are some striking instances in the Désert de Platé.

In other cases the lapiés pass transversely over a fissure and continue on its other side, as if it did not exist. In such cases the fissures are filled and knit together with calcite. The Désert de Platé affords good examples.

If the limestone beds are vertical or very steeply inclined, the channels are as a rule developed along joints; but lapiés on joints are not so typical as those developed on the surfaces and outcrops of limestone beds; moreover,

in the case of vertical beds, scattered limestone monoliths are rapidly formed out of the lapiés ridges.

The dependence of the form and situation of lapiés upon joints is seen on the elevated platform of Velika Čvrsnitsa in Bosnia, which is composed of compact limestone that dips towards the southwest. Each of the lapiés ridges slopes towards the southwest in conformity with the inclination of the beds and the joints. The same is true of the inclined lapiés of Lupoglav and Velebit.

In the Dinaric karst it is clearly apparent that the most typical lapiés are developed at places where the rainfall is greatest, or where the amount of running water is considerable. Such, for example, are the smaller platforms,

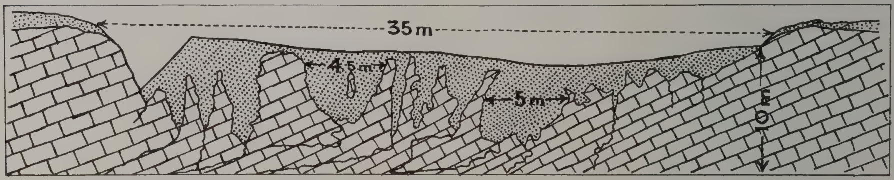


Fig. 21—Lapiés formed in limestone covered by residual clay. In a quarry near Generalski Sto, on the railway line Zagreb-Rijeka, in Croatia. When the lapiés ridges are destroyed, a doline will be formed, filled with clay.

composed of pure limestone, which are separated from the more elevated land by scarps. Besides the water derived from precipitation on the platform, streams of meteoric water flow down from the higher ground over the scarps to the lower platform. On that account scarps and platform exhibit extensive lapiésation.[13]

Effect of Surface Slope and Vegetation

Slope of the ground has some influence on the depth of the channels and on the greater or less lapiésation. Typical lapiés occur chiefly on moderately steep slopes, but they are to be found also on very steeply inclined surfaces. On horizontal surfaces lapiés are rare and, where they do occur, are irregular —a medley of short channels and ridges. The contrary is the case with dolines, which very rarely occur on inclined surfaces.

Lapiés are much more extensive where the surface is not covered with vegetation or soil and in places where no talus slopes are developed. The formation of lapiés beneath a cover of decayed vegetation or earth is not impossible, but such cases are much rarer than on bare surfaces. However, in the Dinaric karst I have also observed lapiés formed under a layer of loam, as is shown in the above sketch. Since the limestone regions of central and northern Europe are mostly covered by a thick layer of loam or other unconsolidated material, lapiés are much rarer there than in the bare regions of the Mediterranean karst; in fact, in the former regions they are usually not developed at all.

[13] Friedrich Katzer: Karst and Karsthydrographie, *Zur Kunde der Balkanhalbinsel. Reisen und Beobachtungen, herausgegeben von Carl Patsch, No. 8*, Sarajevo, 1909.

FIG. 22

FIG. 23

FIG. 22—Destroyed and, beside them, renewed lapiés. Sivadija, Prenj.

FIG. 23—Limestone monolith of ancient lapiés and the formation of new lapiés. Tulove Grede, Velebit.

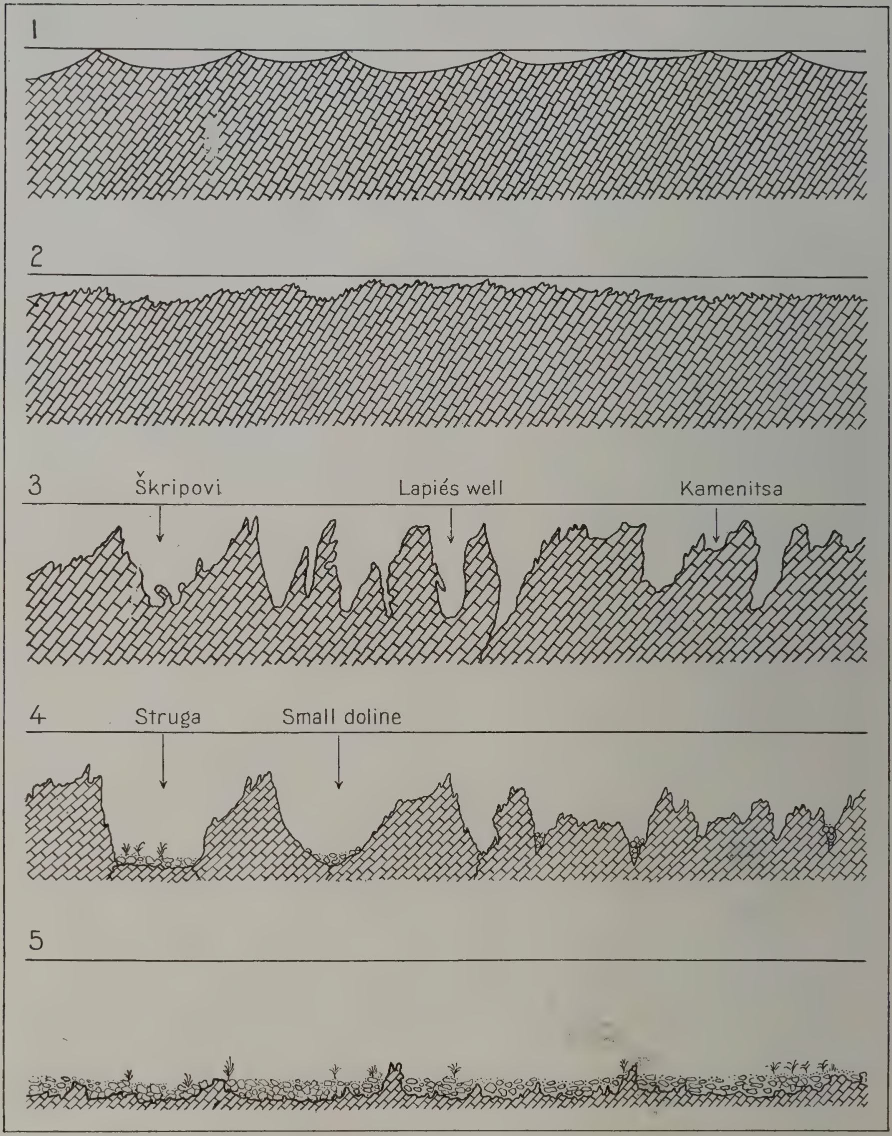


FIG. 24—The evolution of lapiés.

Nos. 1 and 2. The first stage in the development of lapiés: shallow channels separated by low, sharp-pointed ridges, or undulating scoriaceous lapiés.

No. 3. Completely developed lapiés, or stage of maturity: the channels 3-4 meters deep; škripovi and lapiés wells occur, while on the ridges there are hollows (*kamenitsas*).

No. 4. The decline of lapiés, or beginning of the senile phase: the narrower ridges spall, their number is reduced, while the channels between them are wider; the bottoms of some of the channels are filled by stones; in others *strugas* and small dolines are being developed.

No. 5. The cycle ends with the almost complete disappearance of the ridges, only remnants surviving; the former lapiés surface is buried beneath blocks formed by the spalling of the ridges.

Stages in the Evolution of Lapiés

The formation and destruction of lapiés is a process by which the surface of the karst is being degraded and carried away at a rate perhaps more rapid than in any other karst form.

The formation of lapiés begins immediately after the limestone is laid bare. It may affect a limestone mass as soon as it has been elevated above sea level or as soon as impermeable beds have been removed. The evolution of lapiés therefore begins simultaneously with that of other karst phenomena.

FIG. 25—The last remnants of lapiés and lapiés stones. On the road between Rakovitsa and Plitvitsa Lakes, Croatia.

They are, however, comparatively short-lived forms. As time progresses the channels of the lapiés become deeper and wider and the ridges narrower —the process being the more rapid the purer the limestone and the greater the rainfall. Eventually there comes a time when the ridges split off and spall; the limestone blocks thus formed are dissolved by meteoric water and gradually disappear. Then formation begins anew. Lapiés, therefore, pass through a certain cycle of evolution, the stages of which will now be briefly defined.

Stage of Youth

Initial or young lapiés present parallel series of shallow channels, between which are low and usually sharp ridges resembling the fluting of the Doric column or having the appearance of a gently undulating scoriaceous (honey-combed) surface. Both initial forms may be observed in places where the

limestone surface has been recently bared and exposed to the influence of running water.

A further stage in development is constituted by the undulating or *chaotic lapiés*, furrowed by deeper channels of which the cross sections show sharp wavelike contours. This is a transitional form which attracts less attention than the initial forms, or still less than those which follow, i. e. the *normal lapiés*, or lapiés proper completely developed, or at the stage of maturity.

Stage of Maturity

In this stage exist the greatest vertical intervals between the bottom of the channels and the peaks on the ridges. In the channels and on the ridges occur the larger forms described above: *škripovi*, lapiés wells, *yapagas*, and rock hollows. The lapiés have reached the greatset diversity of form, and the sides of the ridges the steepest possible inclination. Such sharp forms cannot be maintained: destruction commences, and thus old age is reached.

Old Age

The ridges become disjointed and shattered into blocks and fragments of limestone that fill the channels. As a rule, the sharpest ridges disappear first, several channels thus becoming united into one and forming first *strugas*, then small dolines, either circular or, more particularly, small but narrow oval dolines. As the limestone of the splintered blocks and fragments is removed by solution *terra rossa* is left, along with other clays, as a thin soil on which vegetation takes root. It is true that in the preceding stages a scant and unexacting vegetation of mosses and lichens may be seen here and there among the lapiés. But now grasses, bushes, and an occasional tree begin to populate the spaces between the spalled blocks, thus hastening the process of lapiés destruction.

Before lapiés are so reduced as to be unrecognizable, a characteristic transitional stage with the larger features—*strugas* and small dolines—is often to be observed, at least in the Dinaric karst; many of the ridges have disappeared, while the channels are heaped with limestone blocks and fragments often covered by clay, produced by weathering, and with vegetation. This phase in the development of lapiés is well defined at Tulove Grede in Velebit.

Evolution ends with the almost complete disappearance of the lapiés—reduced to heaps of limestone blocks resting on an uneven surface, on which can be recognized remnants of fretted ridges and buried channels out of which chaotic mass there rise in places residual monoliths. The quantity of spalled rocks is not equal in proportion to the mass of the fallen ridges, because of the continuous solvent action of the meteoric waters. The heaps are often covered by *terra rossa* and vegetation. This might be termed the stage of *esserts*, since such lapiés are so called in Romance Switzerland.[14]

[14] Émile and André Chaix, *op. cit.*, p. 38.

The evolution of lapiés may be stopped earlier, so that they do not pass through the complete cycle, if thick beds of marly limestone, of sandstones, schists, and melaphyres, or of dolomite are intercalated in pure limestone. This is very often the case in the Dinaric karst. But, if limestone occurs again below these rocks, then, after they have been removed by erosion, young lapiés will begin to form again on the newly exposed limestone surface.

Whether the above-mentioned intercalated beds exist or not, regeneration of lapiés begins again after completion of the last stage; and the cycle will be repeated until the lapiés channels reach that layer in the limestone which is permanently saturated with the network of the underground sheet of water. At that point the regeneration of lapiés is stopped definitively. It can be renewed only in case of tectonic processes, by uplift of the land and consequent lowering of the water table.

A CRUISE WITH THE INTERNATIONAL ICE PATROL

By Robert De C. Ward
Harvard University

The International Ice Patrol was established as a result of the sinking of the great passenger liner *Titanic* by collision with an iceberg in the spring of 1912.[1] One month after that catastrophe the U. S. Hydrographic Office made a recommendation to the Navy Department that one or more naval vessels should patrol in the vicinity of the steamer lanes and warn passing ships of ice danger. Such a patrol was at once put into operation. The following year the U. S. Revenue Cutter Service (now the Coast Guard) took over the task, with two cutters alternating in the service, while the British S. S. *Scotia*,

Fig. 1—The *Tampa* lying close to an iceberg.

well known as an Antarctic exploring ship, co-operated and completed a valuable series of meteorological and oceanographic observations. In the autumn of 1913 an International Conference for the Safety of Life at Sea was held in London, as one result of which fourteen maritime nations agreed (Jan. 20, 1914) to maintain a continuous patrol of the area of the North Atlantic most endangered by ice during the ice season. The United States Government was asked to undertake the management of this service, and each of the contracting Powers agreed to assume a share of the expense in proportion to its shipping tonnage. Since 1914, with the exception of 1917 and 1918, during the war, the Ice Patrol has been maintained by the U. S. Coast Guard.[2]

[1]The *Titanic* sank on April 14, 1912, in latitude 41° 46′ N., longitude 50° 14′ W. Over 1500 lives were lost.

[2] The U. S. Coast Guard and the U. S. Hydrographic Office co-operate in the administration and operation of the Patrol. The former furnishes the ships and the men, while the latter disseminates the information collected by the Patrol vessels to shipping interests and also controls the shifting of the steamship tracks. Administrative matters are vested in a Board composed of the Commandant of the Coast Guard, the Hydrographer of the Navy, the Director of the Bureau of Standards, the Chief of the Weather Bureau, and a member of the Fisheries Board. Dr. Henry B. Bigelow, of Harvard University, is an honorary member and scientific adviser. The Commandant of the Coast Guard is president of this Board.

Each year the U. S. Coast Guard details two of its newest and best-equipped cutters for the service. During the past two years the *Modoc* and the *Tampa*, sister ships, have been assigned to this important duty. From March through June, and into July if necessary, these vessels base on Halifax, N. S., where they obtain fuel and supplies. They alternate in cruising in the ice region, the period of duty being fifteen days on actual patrol,

FIG. 2—Chart showing the general drift of ice which menaces North Atlantic steamship traffic. Reduced from Chart A, Pilot Chart of the North Atlantic Ocean, March, 1923.

exclusive of the time occupied in going to and from Halifax. The officer in charge of the scientific work of the Patrol for the past five years has been Lieut. E. H. Smith, who during the last two years has spent all of each ice season on the high seas, transferring from one cutter to the other at the end of each fifteen-day period. Under this plan one man, who knows the locations and movements of all menacing icebergs and has prepared all the charts, is on duty continuously for about four months, with the resulting obvious advantage of continuity of work and of responsibility.

By invitation of Rear Admiral W. E. Reynolds, Commandant of the U. S. Coast Guard, the writer was given the privilege of taking part in the

cruise of the *Tampa* on Ice Patrol duty from June 16 to July 2, 1923 (see Fig. 6).[3]

THE LIFE HISTORY OF THE ICEBERGS IN THE DANGER ZONE

The essential facts regarding the ice which menaces North Atlantic steamship traffic may be briefly stated. Most of the bergs come from the fringe of

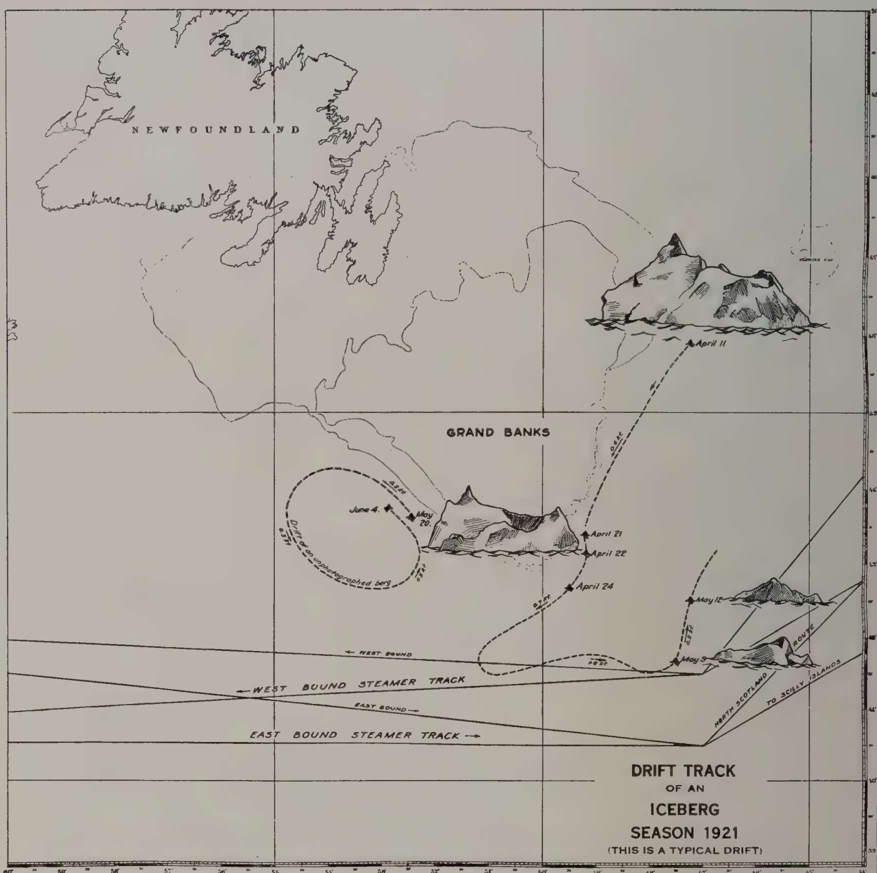


FIG. 3—Typical drift of an iceberg off the Grand Banks. Reduced from Chart B, Pilot Chart of the North Atlantic Ocean, March, 1923.

glaciers bordering the west coast of Greenland, east of Baffin Bay, and represent the wastage from the Greenland ice cap[4] (see Fig. 1). A few come

[3] The writer is under great obligations to the commanding officer of the *Tampa*, Lieut. Commander William J. Wheeler, for unfailing courtesy and thoughtful attention throughout the cruise; to Lieut. Edward H. Smith for most helpful interest and co-operation; and to the other officers of the ship for favors. Fuller details concerning the work of the Ice Patrol and the movements of the ice may be found in the following articles by Edward H. Smith (Lieutenant, U. S. Coast Guard): "Some Meteorological Aspects of the Ice Patrol Work in the North Atlantic," *Monthly Weather Rev.*, Dec., 1922, pp. 629–631; and "Practical Knowledge Regarding Iceberg Drifts for Trans-Atlantic Navigators," *Pilot Chart of the North Atlantic Ocean*, March, 1923, U. S. Hydrographic Office. The writer acknowledges his indebtedness to Lieut. Smith's articles, from which many of the facts here given were obtained and from which two charts (Figs. 2 and 3) were taken.

[4] Cf. C. F. Brooks: The Ice Sheet of Central Greenland: A Review of the Work of the Swiss Greenland Expedition, *Geogr. Rev.*, Vol. 13, 1923, pp. 445–453.

from the east coast of Greenland, round Cape Farewell, and travel north as far as Davis Strait before turning south in the Labrador Current. Others doubtless start in the Smith Sound region and even farther north. One glacier in West Greenland is reported to "calve" on the average one iceberg a day, and this record is probably equaled in other cases also. Once icebergs are afloat and free to move they start to drift under the influence of the currents and winds. Many doubtless never leave their home latitudes. Others, after drifting to and fro, find their way into the cold current flowing southward through Davis Strait, known farther south as the Labrador Current. Some of these become stranded off the Labrador coast. Others ground on the northern slope of the Great Bank. Others move westward along the southern coast of Newfoundland. Relatively few eventually travel eastward and then southward towards the Tail of the Bank; it is these which constitute the greatest danger to transatlantic steamers while following the most-used steamer lanes. Here the interplay of the cold Labrador water and the warmer Gulf Stream water, resulting in a more or less complex and varying series of eddies and currents, carries the bergs back and forth. Their courses,

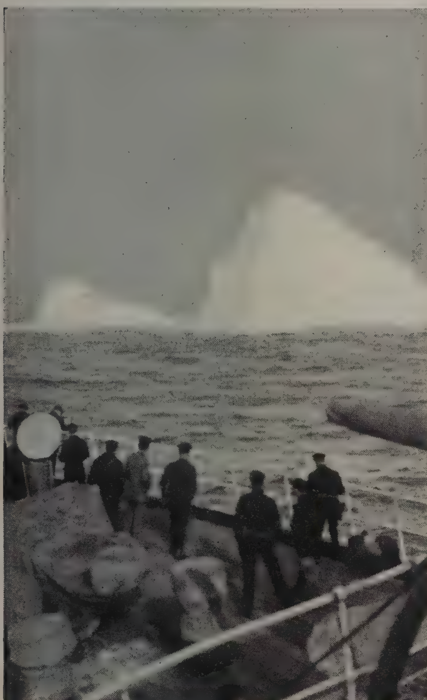


FIG. 4

FIG. 5

FIG. 4—A pyramidal berg, from the bridge of the *Tampa*.

FIG. 5—Crew of the *Tampa* swimming in the Gulf Stream within sight of an iceberg.

which often seem erratic, now appear, after careful study, to conform more or less to certain general rules. The typical drift of a large berg during the period from April 11 to May 12, 1921, is shown in Figure 2. This berg was identified by means of photographs and in other ways; it was sighted four times during the month, and its track was carefully computed and plotted.

The rate of drift of icebergs varies a good deal, a maximum of about 0.7 knot an hour has been observed late in the season in the cold current around the Tail of the Bank. It has been estimated that if a berg keeps in the current, it will take it about five months to travel from Cape Dyer, Baffin Land, to south of latitude 45° N. Bergs do not long survive in the warm waters of the Gulf Stream, and they rarely drift more than a few miles south of its northern margin. It is therefore the marginal region between the cold and the warm currents that is the critical one for shipping; and it is the determination of the shifting boundary line between the safe and the unsafe areas which is one of the constant duties of the Ice Patrol. Hence the great importance of an accurate knowledge of the water temperature, in ascertaining which the co-operation of all steamers in the danger zone is asked and expected. The dividing line between Labrador Current and Gulf Stream is often very sharply defined, not only by temperature but also by the color of the water and by the "rips" which are seen and felt between the two currents. As regards temperature differences, reference may be made here to an occasion in 1922 when the *Tampa* was placed directly across the "Cold Wall," the water temperature at the bow being 34° and at the stern 56° (see also Fig. 5).

The regular steamer tracks between Europe and the United States are located to the south of the southern end of the Labrador Current, where that current is turned backward and eastward by the Gulf Stream at the Tail of the Bank (note drift of iceberg, April 21–May 12, Fig. 3). Were the ice always in the same zone, the situation would be a simple one. The difficulty is that the number of bergs varies greatly from year to year and that in some years they drift much farther southward than in others. It is on this account that the continued and regular work of the Ice Patrol is so important.

General Tactics and Routine on an Ice Patrol Cruise

Stated specifically, it is the duty of the Ice Patrol ship to determine the southern, eastern, and western limits of the ice and to keep in touch with this ice as it may move into the vicinity of the regular transatlantic steamship tracks. This duty involves a detailed search of the ocean area in the vicinity of the "tail" of the Great Bank of Newfoundland, and therefore usually keeps the Patrol vessel somewhat to the north of these tracks. Whenever the visibility is good, the Ice Patrol ship "combs" the critical areas, steaming on a rectangular, triangular, or zigzag course, keeping careful lookout for ice, both from bridge and crow's nest. When a berg is discovered, the course is changed so as to bring the ship near it. The berg is then examined at close

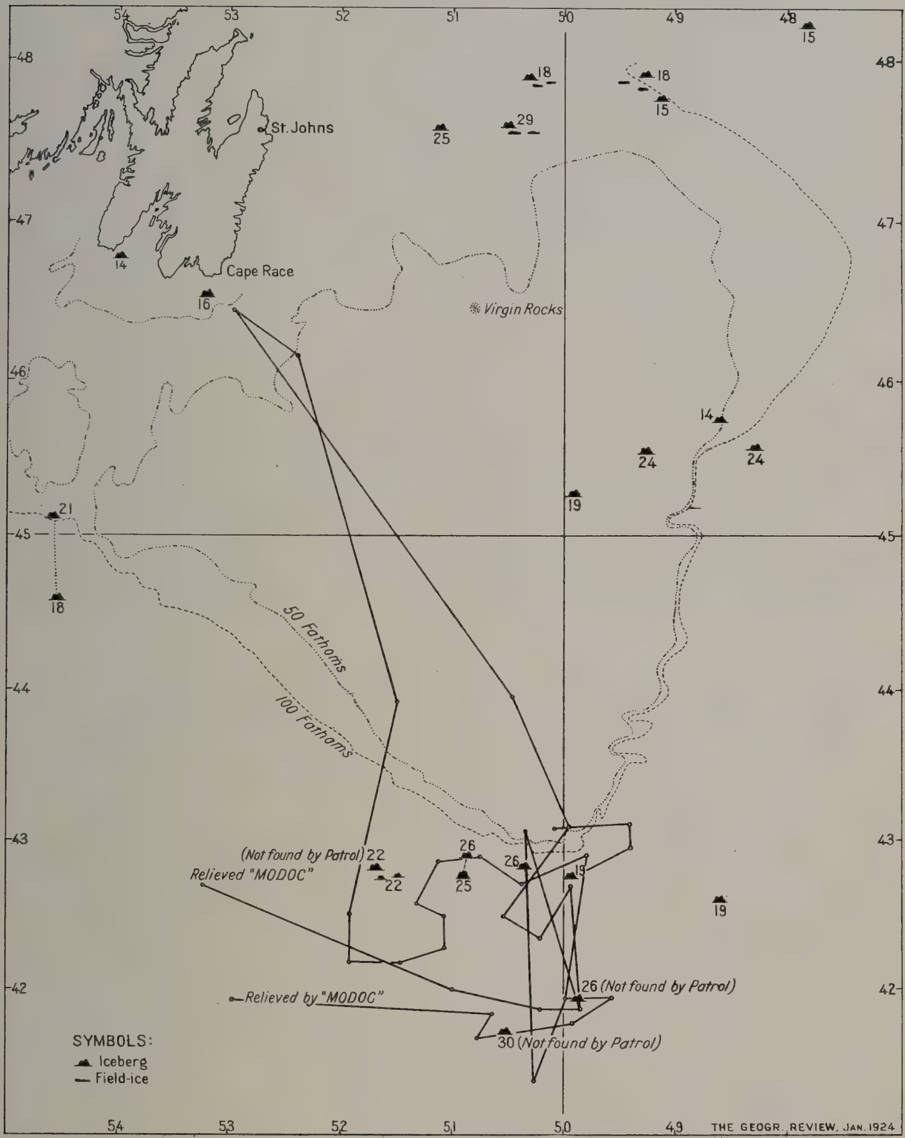


FIG. 6—Noon positions and iceberg chart, June, 1923, cruise of the U. S. Coast Guard Cutter *Tampa* on Ice Patrol. Figures have reference to days of the month on which the respective bergs were sighted.

range and sketched or photographed so that it may later be identified. Its position is also plotted on the chart. In thick weather, and especially in fog, searching is out of the question. The Patrol ship therefore usually drifts or, if she is on the Great Bank, anchors until the search can be renewed. Drifting is often done in fairly close proximity to an iceberg, in order that the rate and direction of its movement may be studied. On her May cruise, the *Tampa* kept her searchlight playing on an iceberg during a dark and stormy night in order that the berg might not be lost sight of.

Even when lying still, the Ice Patrol ship is a busy place. She is the "clearing house" for all information about ice. Every vessel passing through the ice region (between longitudes 43° and 55° W.) is expected to send by radio to the Patrol vessel exact information as to any ice sighted, as well as four-hourly reports of water temperatures and other data. As each vessel enters this area, her successive positions are plotted on board the Patrol ship, so that her course may be followed stage by stage during her progress. If any passing steamer is seen to be in danger, a message is sent to her, informing her of the location of any neighboring berg and advising a change of course. When a report comes in to the Patrol ship of an iceberg not previously seen and charted and in a dangerous position, a broadcast is at once sent out so that all vessels may be warned. At the same time the Patrol ship immediately steams to the reported position of the new berg. Thus, in the case of the *Tampa*, on two occasions during the June cruise such reports of ice led to the vessel's steaming a distance of 50 to 75 miles in order to investigate, and on one of these occasions the trip was made through dense fog. Again, inquiries often come in asking whether a certain vessel, following a certain course, is likely to meet ice. To all such questions immediate and full replies are sent. It not infrequently happens that vessels reporting ice give a position for the berg which is many miles out of the way or even report a "berg" which careful search fails to reveal at all and which may have been a distant cloud.

In addition to the numerous individual messages sent to passing ships, several regular broadcasts are sent out each day. Twice daily, at 6 A. M. and 6 P. M. (75th meridian time), a broadcast is sent to all vessels, giving full information regarding the position of all dangerous ice. Once a day, at 7 P. M. (75th meridian time), a message is sent to the Hydrographic Office in Washington giving all essential facts as to ice and defining the ice danger zone.[5] Twice daily, at 7 A. M. and 7 P. M. (75th meridian time), a message is sent to the Weather Bureau in Washington, covering the regular meteorological observations.

Oceanographic Stations

At various times during the Ice Patrol season, as opportunity offers, observations of deep sea temperatures and salinities are made at a series of oceanographic stations arranged along five lines radiating from a central point on the southern part of the Great Bank. The observations thus collected during the past few years by the Ice Patrol furnish the most complete body of data available for the study of the ocean currents of this part of the North Atlantic. On the June, 1923, cruise of the *Tampa*, as no ice duty farther south was immediately pressing, a series of such observations was made along a line of stations extending north across the central part of the Great

[5] A sample of such a report is the following: Our position lat. 40° 33′, long. 48° 20′; three bergs within radius of 5 miles. Fog shrouds them at times; very dangerous to west-bound traffic. A few bergs along east side of Grand Banks and around tail. One berg, lat. 42° 52′, long. 49° 51′; one berg, lat. 42° 42′, long. 49° 42′; one berg, lat. 48° 07′, long. 45° 55′. Many bergs between Flemish Cap and Grand Banks. Fifty growlers northeast of Cape Race.

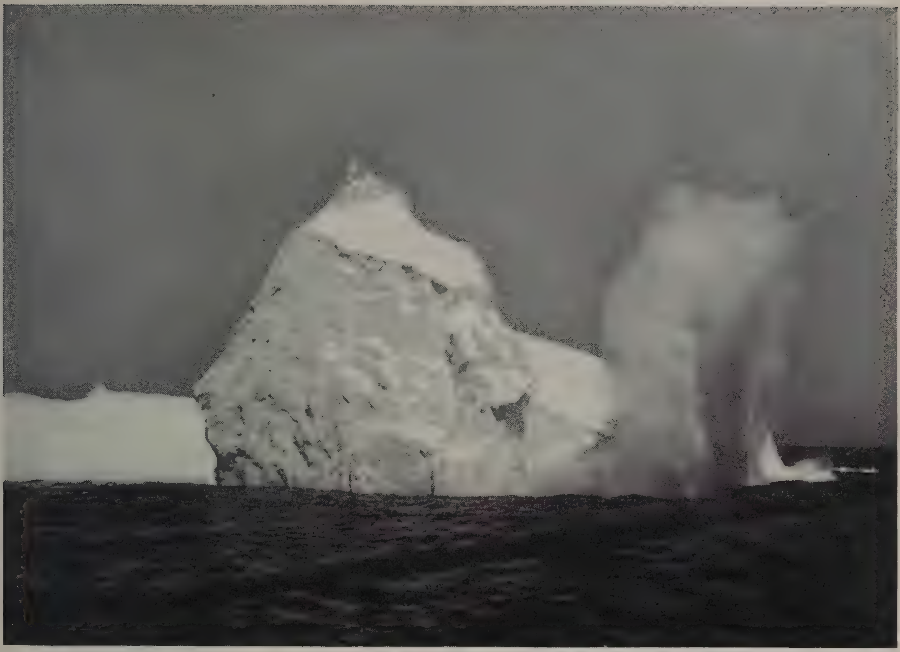


Fig. 7

Fig. 8

Fig. 7—Shortening the life of an iceberg by means of a wrecking mine.

Fig. 8—The result of the explosions in breaking up the iceberg.

Bank towards Cape Race. This portion of the cruise took the vessel into the highest latitudes reached during the fifteen days. The northernmost position was within about 25 miles of Cape Race.

Steamer Tracks

The ice conditions found by the Ice Patrol are the determining factor in fixing the location of the transatlantic steamer tracks. These tracks are moved extra far to the south, even south of the usual summer tracks, when the ice is especially far to the south and east of the Bank, thus lengthening the course but contributing very greatly to safety. Towards the end of June, a radio message reached the *Tampa* from Washington, asking whether the Ice Patrol would advise or recommend having the tracks shifted northward on July 1. In view of the recent report of an iceberg not far from the steamer tracks, the reply was sent that a delay in shifting the tracks was considered advisable. In this connection mention may be made of a novel method of decreasing danger from ice which was tried during the May, 1923, cruise of the *Tampa*. T.N.T. wrecking mines were used on four successive days in order to shorten the life of a berg which had drifted dangerously near the steamship lanes. The berg was already softened by being in warm air and warm water, but it is believed that its end as a danger to navigation was hastened by fully two days as the result of the explosions (see Figs. 7, 8). The use of wrecking mines for the purpose of destroying icebergs is not feasible or practicable under ordinary circumstances. In the case here referred to, the berg was already in a stage of disintegration. It should be remembered that a large berg in cold water contains many thousands of tons of hard ice. A berg 65 feet high and 1690 feet long, seen by the *Tampa*, was calculated to contain approximately 36,000,000 tons of ice! The destruction of such a mass is obviously quite beyond human power, especially under the conditions obtaining at sea.

Some Typical Icebergs

Although the June cruise of the *Tampa* came just at the end of the 1923 ice season, several icebergs dangerous to navigation were seen at very close quarters. Two of them were of a common type: low, elongated, and well waterworn masses; without pinnacles or vertical sides; and of a general "saddle-back" form. One whose height was roughly 35 feet measured in length 100 to 150 feet, and in width perhaps 75 feet. One had two distinct streaks of dirt in it and showed a well-marked fissure, extending from top to bottom, which was filled with a more bluish ice than that of the berg itself. The second, with many distinct waterworn gullies on its surface, showed a former sea-level erosion line tilted up at an angle of nearly 90°, indicating that the berg had lately shifted its position by that extent. A rough calculation gave a weight of about 30,000 tons to the larger of these two bergs. The other bergs were of the pinnacled type. A small one had a height of about 75 feet

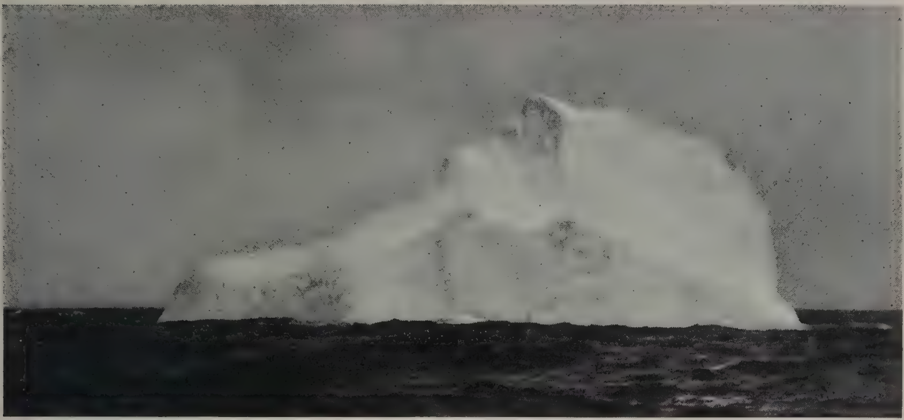


FIG. 9

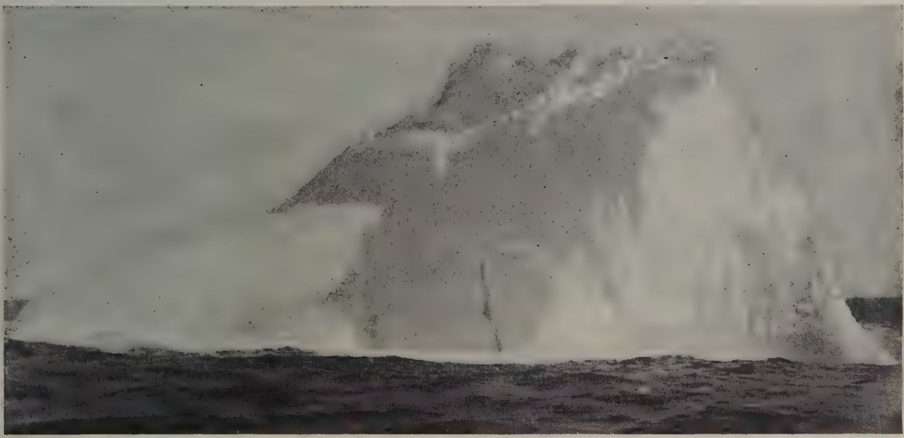


FIG. 10

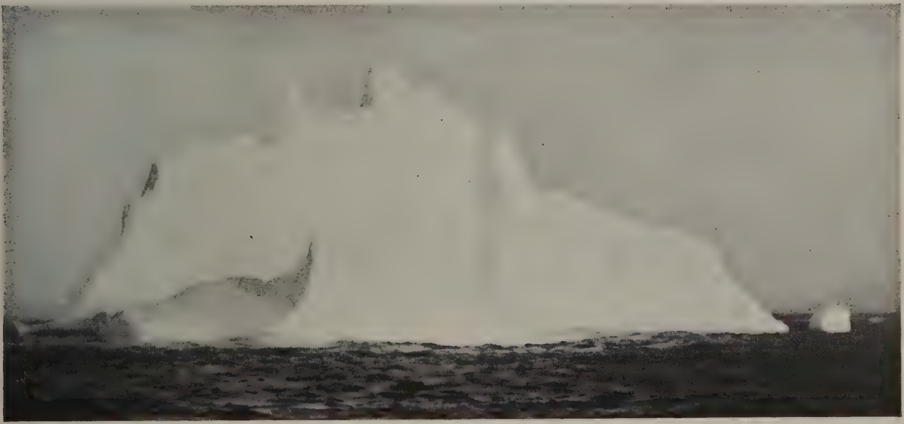


FIG. 11

FIG. 9—A berg well smoothed by wave action and by melting.

FIG. 10—A massive iceberg water-worn near the sea surface.

FIG. 11—Iceberg with two vertical faces and a small "growler."

and a length of 200 feet and had apparently lately split through, as one end presented a sheer vertical face from top to bottom. This berg could be seen long after the *Tampa* had left it, away on the horizon, reddened by the rays of the setting sun. The largest berg was 170 feet high from the ocean surface to its topmost pinnacle, as determined by angular measurements from the bridge. From its highest peak it sloped symmetrically towards its lowest point. On one side there was a sheer vertical face from top to bottom. This last berg was by far the largest, most majestic, and most impressive which was seen. All the bergs had numbers of small "growlers" drifting near them.

The size of icebergs is usually greatly overestimated. The Ice Patrol often receives reports of bergs stated to be 300 to 400 feet high and half a mile long. During four years past, of the two largest bergs observed one was 248 feet above the water at its highest point, and the other was 1690 feet from end to end. These were accurate measurements, made with a sextant.

Daily Weather Maps Based on Radio Reports

In addition to keeping a fairly complete meteorological log the writer constructed daily synoptic weather maps for the eastern United States, based on the regular Weather Bureau observations broadcast from Arlington.[6] With a few exceptions, a map was drawn every morning on the basis of the 8 P. M. (75th meridian time) observations, and on most days a second map, based on the 8 A. M. observations, was also constructed. In addition to the land stations regularly included in the broadcast, reports from vessels at sea received by the *Tampa*, as well as the observation made on the *Tampa*, were also used in preparing these maps. The construction and study of the maps proved most interesting, not only from the point of view of the weather conditions prevailing at home, but also because of their use in making general forecasts for the western North Atlantic. Such forecasts were made daily on board by the writer and were not without interest and value. The development and the later break-up, over the eastern United States, of the hot wave of the third week of June was carefully watched on these daily maps constructed at sea. The passage eastward down the St. Lawrence valley, or farther to the south, of several depressions was also watched with interest with reference to their possible control over the weather at sea. With one exception, however, these June cyclonic areas were too weak and passed too far to the northward to cause any appreciable disturbance over the area of the *Tampa's* cruising. Conditions in the eastern United States favorable for heat and for wind-shift line thunderstorms were readily picked out, even on the incomplete maps constructed on shipboard.

Suggestions for Construction of Weather Maps at Sea

With regard to the use, in the construction of daily weather maps at sea, of meteorological observations received from other vessels, the writer's own

[6] This was possible through the generous co-operation of Chief Radio Man Reynolds of the *Tampa*.

experience leads him to make the following suggestions. Under the present plan, all vessels in the danger zone are expected to report to the Ice Patrol ship, regularly every four hours, their position, course, speed, and water surface temperatures. These reports vary greatly in their completeness and accuracy. There is diversity as to the hours of observation and often extreme uncertainty as to what time is used, whether G. M. T. (Greenwich mean time), or ship's local time, or 75th meridian time. Some vessels report barometer reading, wind direction and force, weather, state of sea, etc., while others do not. Further, a study of the barometer readings reported to the *Tampa* showed beyond question that these were often considerably in error and therefore not comparable or of value in drawing a synoptic map. These difficulties in the pressure readings probably result from (1) instrumental errors; (2) differences in elevation above sea level; (3) carelessness in observation; and (4) other causes. If it is desirable that regular daily weather maps should be properly constructed on board the Ice Patrol ships and that such maps should become of real use in forecasting at sea, it is suggested that definite arrangements be made with the regular passenger lines whereby two of the usual four-hourly observations now requested should always be made at 8 A. M. and 8 P. M., 75th meridian time (G. M. T., 1 A. M. and 1 P. M.), in order that they may synchronize with the Weather Bureau broadcasts; that the ship's barometers should frequently be compared with a standard and the corrections determined; and that greater care should be taken in making all the observations. The complete record, to be sent to the Ice Patrol ship at 8 A. M. and 8 P. M. (75th meridian time) in systematic and regular order, would be as follows: name (letters) of vessel; time (G. M. T., given in a four-figured group of numerals, starting with 0000 at midnight); latitude; longitude; course; speed; surface water temperature; air temperature; barometer (reduced to sea level); wind direction and force; fog (yes or no); remarks. This same scheme might well be followed in sending the regular four-hourly reports already asked for by the Ice Patrol.

THE MOHAMMEDAN WORLD

By Isaiah Bowman

[With separate map, Pl. I, facing p. 72]

Unlike Christianity and Buddhism, the Mohammedan religion does not confine itself to the realm of ideas and their influence upon the spirit of man: it is a religion of force and authority, a system of law, a political guide, a basis of government. Upon the quarreling Arabian tribes that he brought together Mohammed impressed the fact that they were joined by a common bond—war against the non-Moslem world and the extension of Moslem authority. The Hejira took place in 622, and Mecca was gained in 629. It results that Mohammedanism has had thirteen centuries in which to exercise its influence, and in that time it has had abundant opportunity to make its power felt over a wide area and among many different kinds of people. It has been affected by neighboring states that have passed through whole cycles of cultural and political development, disunion and union, expansion and defeat, and finally the World War.

The Historical Background

In short, Mohammedanism has had full opportunity to discover the weaknesses and foil the strength of its chief opponents. May we not ask ourselves at this time, therefore, if anything in that history or in the present situation of the Islamic world furnishes ground for fear that it may issue forth from its vast realm to the undoing of western civilization? During the World War and immediately thereafter there seemed to be an immense stirring within the Mohammedan world. There were many attempts at achieving solidarity of political purpose, for example through the related but quite unlike and in some respects rival programs of Pan-Turkism and Pan-Islamism. The Mohammedans gave the British serious trouble in northwestern India. Egypt has passed through some of the most difficult stages in its history in the past five years; the French have had constant trouble on the Syrian frontier; and Turkey, the most important political unit of the Mohammedan world, refused to sign the Treaty of Sèvres, broke up the first Near East Peace Conference at Lausanne, and at the second conference refused outright to continue the policy of the capitulations and the service upon the pre-war Ottoman debt.[1] A survey of these more recent circumstances and a glance down the perspectives of history furnish ample material for a lurid picture of disaster to

[1] Cf. the article "Geographical Elements in the Turkish Situation: A Note on the Political Map," *Geogr. Rev.*, Vol. 13, 1923, pp. 122–129.

modern civilization should the power of the Mohammedan world be thrown against it. One must admit that the historical facts when viewed superficially are rather ominous. Entering Spain in the seventh century, the mixed breeds of North Africa under the name of Moors penetrated the peninsula, crossed the Pyrenees, and by the early eighth century fought out the issue on the plain of Tours (732). Finding Spain disunited and the climate congenial, the invaders established themselves with such success that it was not until seven centuries later that the last of their strongholds was taken, though effective Moorish control had ended two centuries before. Thus for over half a millennium the Moor dominated the Iberian Peninsula. In the fifteenth century the Mohammedans crossed over from Anatolia to the northern shore of the Aegean, established a capital at Adrianople, swept over the Balkans in all directions, captured Constantinople in 1453, and advanced toward the interior of Europe with marked success. But it was only after united and protracted effort that the second siege of Vienna was lifted so late as 1683. In 1571 the power of the Turkish fleet was broken at Lepanto.

If we look at the sort of country from which the Moslem comes and recall the fact that the horseman as an instrument of empire was also employed by Jenghis Khan and Tamerlane in the wide extensions of their temporary empires, we see the force and impressiveness of these examples of invasion of the western world. There is something appalling in the swiftness and ruthlessness with which they were carried out, and especially in the length of time it has taken to rid Europe of the Moslem menace in the Balkans, a region so near that European industrial power could here strike its most effective blows. Against this background of historical fact, we have the present state of unrest and religious and political agitation in the Mohammedan world, the latest success of the Turks, the founding of the new kingdoms of Hejaz and Iraq: it is easy to persuade oneself that we have here a menace of the first order against which the united forces of Christendom must be thrown if modern civilization is to stand.

Of course anything may happen to the western world, and any accident may betray it if it chooses to live in a disunited state. The twenty-six so-called Christian nations of Europe united against Islam is a pretty thought; but all of them will have to see Mohammedanism as an overwhelming menace before such a union takes place, for the mutual fears, jealousies, hatreds, and ambitions of the European states are objects of far livelier concern, either because the Moslem menace seems far away or because it otherwise appears to lack reality. Should blindness to this or any other menace carry the civilization of Europe to the brink of disaster, it would of course need but little force to push it over the precipice. But if we assume that Europe will again start going its now all-but-idle economic machinery, how real is the so-called Moslem menace? Even if we assume that the new Turkish government represents modern ideas in industry, transportation, sanitary measures, and respect for financial obligations,

what power stands behind it which Europe would do well to heed even if it does not fear?

There is much geography in the analysis and conclusion of the matter. The accompanying maps (Pl. I, facing p. 72) have been prepared to reduce the discussion to its briefest terms. In fact, this paper is essentially a statement of the meaning of the maps. They should be reviewed before the reader takes up the argument that follows. What is the geographical relation of the Mohammedan world to the rest of mankind, what resources are behind it, what geographical conditions circumscribe its activities and limit the exercise of force either by it or upon it from the outside? The accompanying maps point out the rigorous conditions under which most Mohammedans live, the very special nature of the vast tract in which their religion dominates, and, above all, the fact that the Mohammedan realm is not to be considered as a vast reservoir of power from which may be drawn the means for carrying modern war into the European field. Mere area upon the map may be impressive, and mere enumeration figures likewise; but the character of the land and its resources and the disposition of the population are the essential things, and these give no basis for a broad conclusion that the Mohammedan world need be a menace to Europe.

Population: Numbers and Disposition

Let us first turn to the physical layout of the Mohammedan world with special attention to its borders, for there live most of the population and there are the contacts of greatest political significance. The 270,000,000 Mohammedans[2] are disposed for the most part in and around a broad belt of country about four times the area of the United States, or roughly 12 million square miles, extending across northern Africa from the Mediterranean to the Sudan, thence eastward across Arabia and Anatolia, Persia, Afghanistan, northwestern India, Russian Turkestan, a belt of territory that practically encircles the Caspian and extends far into China, and having important outliers in the East Indies, as in the Celebes, Sumatra, Malay States, Borneo, and particularly Java. There is a large block of Mohammedan population in the Calcutta district, another block in western China, and a band running down the eastern side of Africa to the region opposite Madagascar. In addition there are many minor tracts, for example Albania and a part of Bosnia, to mention a few among many Balkan examples, besides scattered districts in Central Africa.

If we superimpose upon this great belt of country the line representing an average annual rainfall of 10 inches a year, we have the result shown in Figure B; and, when we consider that for most of that country the line

[2] Figures for population and resources are approximations. Accurate statistics are lacking for the major part of the Mohammedan world. Furthermore it is difficult to define the limits of the "converted" populations in the border regions. René Le Conte in an article "La Géographie de l'Islam" in *Le Mouvement Géographique*, Vol. 35, Nov. 15, 1922, gives an estimate of 225,000,000 of Mohammedan population distributed thus according to zones: in Africa—Atlantic zone, 6, Mediterranean zone, 18, Sudanese and Eastern zone, 25, millions; in Europe, Asia, and East Indies—Arabian zone, 8, Turkish zone, 30, Iranian zone, 11, Hindu zone, 67, Chinese zone, 7, Malay zone, 43, millions.

of 20 inches limits agriculture, though not pasturage, to irrigated tracts, we see at once that huge areas of this vast region can support only the thinnest population and much of it none at all. Or, if we go further and examine the area having 10 inches or less, we see a restriction to irrigated tracts that is so complete as to be a most significant fact, especially if we consider it from the standpoint of Moslem solidarity or the accumulation of material resources for the invasion of other lands. It is true that most of the Mohammedans of India live in a region having less than 20 inches of rain and that the entire population of Egypt (thirteen million in number) lies in the ribbon of lowland favored by the Nile flood and having less than 10 inches of rain. It is also true that these populations have great capacity for troubling the occupying forces of foreign powers and that the occupation of such lands may become more than difficult—it may be impossible either in the near or in the distant future, should troubles continue to thicken about the European governments. But that is a far different thing from saying that the populations that are immediately dependent upon irrigation can take with them into a foreign country agencies or resources that will sustain a military campaign. A population dependent upon agriculture by irrigation is substantially rooted to the soil. It is the nomadic or seminomadic grazing society that is restless and menacing to the settled lands beyond; and such a society is nothing if not widely dispersed.

We thus have withdrawn at the outset one of the most impressive facts of the Mohammedan world, namely the area of the territory under the control of the Moslem. Closely related with this is the distribution of important Moslem units about the borders of the Mohammedan world. It is not the total number in a wide area with large resources upon which our attention should be fixed, but specific units of that world in their critical relation to those that matter to European powers. For example, the thirty-five million Mohammedans of Java have high productive capacity in the field of agriculture: they export foods to other lands; they are more than self-sustaining. But beyond this they are of little consequence in achieving Mohammedan solidarity or expressing that solidarity through political action; for Java is an island, and western Europe controls the sea.

Likewise the map discloses that there are deep arms of the sea penetrating the Mohammedan world, and none of these arms are under Moslem control. There is but one geographical point where a serious question of control must be debated with any portion of that world, and that is at the Bosporus, the control of that strait having been one of the chief points of objection on the part of Turkey to certain terms proposed at the two conferences of Lausanne. Another important block of Moslem population is in Egypt, but sea and desert enclose it. Egypt may agitate and riot and boycott as much as it wishes, yet it remains isolated from the rest of the Moslem world either from the standpoint of effective resistance or from the standpoint of exercising its power in distant countries, so long as the sea is under European control.

Significance of Sea Control

In fact, it is control of the sea and of modern industry that makes the chief difference between the present situation and the situation of past centuries when the Moslem not merely threatened but invaded Europe. In the centuries in which he occupied Spain and dominated the Balkans and threatened Europe the life of Europe was as detached and incapable of effective organization for the achievement of a common object as the Moslem world is today. We see Europe as an immensely fertile area, densely populated and powerful: it requires a conscious effort to realize how divided and difficult a country it was when some of its marginal lands were under Moslem control. It had an immense acreage of forest that has since been largely cut away; its roads served foot traffic chiefly, not wheel traffic. It had nothing at all that resembled modern industry in the matter of materials and resources upon which modern war are based. Since then its forests have been cleared; not merely have roads been built, but an immense network of railroads has united every part; and above all it has turned its technical achievements in the direction of maritime control to such an extent that the sea is today a determining factor in any world organization that must sustain protracted war.

In order fully to realize the bearing of this fact upon the Mohammedan world take the case of the railways. Upon Figure D (Pl. I, facing p. 72) we have shown all the railways in that realm, whether large or small. Outside that realm we have indicated only certain trunk lines of special importance as assets for the Mohammedan world. It is noteworthy that the railways within the Mohammedan world are short, disconnected lines for the most part or mere spurs or extensions of main trunk lines built and controlled from without. The railways of French North Africa are based upon the sea. They lie within the zone of effective and continuous French occupation. The same is true of the railways of Egypt; and the link that connects the railway system of Egypt with that of Syria was built as a strategic line during the war and lies so close to the sea as to be easily kept under the control of sea powers. The railway at the head of the Persian Gulf is based upon the power that controls the Gulf; and so it is all about the border of the Mohammedan world with few exceptions. There is an apparently detached line running through Russian Turkestan, and of course the control of the railway system of Anatolia is now very largely in Turkish hands.

The geographical situation of the railways makes it impossible for them to serve as bonds of union or as sustaining features in a political policy; and their very lack of mobility greatly diminishes their value when studied from the standpoint of sea control. A battleship, on the other hand, is an immensely mobile unit. It represents a high degree of technical skill, both in construction and in operation. There is not enough technical skill in the whole Mohammedan world outside of Turkey either to build or to operate a

single battleship. Moving from place to place, a battleship, or the fleet it represents, is able to focus men and resources upon a given point either as a base for further operations or in the way of attack upon mobilizations of the enemy. The railroad is a fixed thing; it cannot be moved in any strategic sense; the amount of technical skill it represents is less and the quality of it is simple as compared with that required to build and operate a battleship. Moreover, almost without exception the railroad represents a mere point upon the coast, a point that in almost all cases has little particular strategic importance.

Limitations Imposed by Desert Environment

Most important of all is the environment in which the Moslem dwells. Over the greater part of the area in which he lives desert conditions prevail. The sand, the rock, the heat, the absence of water or its great scarcity, the thin and scattered forage, the unimproved natural lines of communication—these constitute the allies of the desert dweller. When the invader comes into the desert these allies fight for the native. The example of Pershing in Mexico in 1916 is illuminating. A deep penetration of the desert section of northern Mexico put him in possession of no important cities and created no fundamental change in the life of the great majority of Mexicans. Pershing's expedition fought not Mexicans chiefly but the hard conditions of mere existence in desert Mexico. The cost of the expedition must be charged to heat and drought and sand and the energy required physically to overcome these by the expenditure of motor trucks, gasoline, oil, and food.

How different is the case when the desert dweller tries to take his resources abroad! In gathering together these resources he is fighting precisely the things that the invader would have to fight. If he gathers forage, food, transport animals, resources of whatever kind, he must fight the unimproved spaces. He suffers from the same lack of water that was the dread of the invader. He finds himself with few transportation lines, for the most part unimproved ports, and the lack of ample sustenance spaces to support his mobilized forces at points of attack. Moreover, not only does his own environment fight him when he tries to use it in carrying his operations into the enemy's country, but he must leave his chief ally behind him. Said Gibbons, "Safety reposes in the heart of the burning solitude." When the desert dweller faces his enemy in his enemy's environment he matches his numbers, his skill, his material resources against those of his enemy on equal terms. His hosts can no longer be dissolved and scattered through the desert; he can no longer conceal his trails and watering places. Standing on a common footing, the disparity between him and his enemy is so great as to leave him no chance at all in the modern world.

At this point we may ask what capacities he has upon his own ground to develop industry and the material power that opposes him when he carries the fight into Europe. Let us look first of all at the natural means of communication. Upon Figure C we have shown the outlines of the area in which

Natural Resources of the Mohammedan World

(After: World Atlas of Commercial Geology; Geography of the World's Agriculture; The Statesman's Year-book; and other sources.)

Commodity (and, in brackets, world's production in 1913)	Locality	Production in 1913	Probable Reserves (in terms of the 1913 world output)
Coal [1,342,333,000 tons]	Asiatic Russia	2,160,000	Great; mainly west of Baikal
	Turkey	842,000	
	Dutch East Indies	411,000	
Oil [514,729,000 barrels (1918)]	Baku	56,500,000	2500%
	Grozny, etc.	11,500,000	1000%
	Uralsk	1,000,000	
	Ferghana	100,000	
	Dutch East Indies	13,285,000	
	Persia	7,200,000	
	Egypt	2,080,000	60%
	Algeria		150% (?)
*Iron [177,207,000 tons]	Algeria	1,210,000	100%
	Tunis	478,000	50%
	Turkey	6,000	
Copper [965,000 tons]	Russia	33,700	Includes southern Urals
	Turkey	500	
	Algeria		
*Lead [1,222,000 tons]	Tunis	28,000	100%
	Algeria	12,000	20%
	Turkey	14,000	
	Egypt	3,000	
*Zinc [386,600 tons]	Algeria	32,000	25%
	Tunis	10,000	40%
	Turkey	2,000	
	Egypt	1,000	
*Gold [$460,500,000]	Dutch East Indies	$3,387,000	
	Malay States	282,000	
	Turkey		
	Egypt		
*Silver [225,410,000 oz.]	Turkey	1,500,000	
	Dutch East Indies	466,000	
	Egypt (1916)	1,650	
	Malay States		
	Abyssinia		
*Mercury [120,800 flasks]	Algeria		
	Turkey		
***Tin** [135,700 tons]	Malay States	52,700	
	Dutch East Indies	21,200	
	Nigeria	3,000	60%

*Indicates that figure gives the output of *metal*, not *ore*.

NATURAL RESOURCES OF THE MOHAMMEDAN WORLD (*Continued*)
(*After: World Atlas of Commercial Geology; Geography of the World's Agriculture; The Statesman's Year-book; and other sources*)

COMMODITY (and, in brackets, world's production in 1913)	LOCALITY	PRODUCTION IN 1913	PROBABLE RESERVES (in terms of the 1913 world output)
Manganese [2,350,000 tons]	Caucasus	1,310,000	In Georgia
*Antimony [19,950 tons]	Algeria	950	120%
	Turkey	300	
Chromite [171,000 tons]	Turkey	14,000	Millions of tons
	India	5,800	
	Baluchistan		
Tungsten [8,120 tons]	Malay States	460	
Phosphate [7,142,000 tons]	Tunis	2,285,000	2700%
	Algeria	378,000	1300%
	Christmas Island	152,000	Near Java
	Egypt	104,000	
Wheat [3,813,010,000 bu.] (av. of 1911–13)	Egypt	35,792,000	
	Algeria	33,177,000	
	Tunis (1919)	6,500,000	
	Morocco (1918)	6,100,000 qu.	
	Turkey		
	Central Asia		
	Persia		
Corn [3,950,375,000 bu.] (av. of 1911–13)	Egypt		
	Morocco		
Barley [1,523,962,000 bu.] (av. of 1911–13)	Algeria	45,000,000	
	Morocco (1918)	7,700,000 qu.	
	Tunis (1919)	5,400,000	
	Central Asia		
Cotton [25,200,000 bales] (av. of 1911–13)	Egypt	1,500,000	
	Central Asia	1,000,000	
	Turkey	200,000	
	Transcaucasia	125,000	
	Persia		
Tobacco [2,661,600,000 lbs.] (av. of 1911–13)	Dutch East Indies	180,000,000	
	Turkey	5,500,000	
	Egypt		
	Algeria		
	Central Asia		
Sheep and Goats [705,000,000 head]	Turkey	51,000,000	
	Central Asia	16,200,000	
	Algeria	7,900,000	
Horses [105,400,000 head]	Central Asia	4,414,000	
	Turkey	1,000,000	

*Indicates that figure gives the output of *metal*, not *ore*.

interior-basin drainage prevails in the Mohammedan world; and by comparison with Figure B, showing the rainfall, we are struck at once with the absence of natural means of communication except in a few isolated cases. The Nile, the Tigris-Euphrates system, and the Volga are the most conspicuous exceptions; and it is only the lower Volga that is bordered by Moslem populations (and these very weak), and it therefore does not form a connecting link between two important units of that world. In all the area shown in color in Figure C the streams run away from the sea, not into it. With the exceptions noted above they are fed by the notoriously intermittent rains of the desert over at least two-thirds of their drainage area, and constitute waterways of only local value to commerce and have limited value as sources of water supply. For the most part the drainage lines are mere dry stream beds with an occasional water hole but no stream except at long intervals of time separated by periods of extreme drought. To this area of interior-basin drainage must be added a still greater expanse of desert where intermittent drainage is also the rule, despite outlet to the sea, and in which the above handicaps operate with equal or even greater effect.

Material Resources

But it is in the field of material resources that we find the Mohammedan world chiefly lacking. In order that this matter may be set forth in the clearest manner, there is presented a table which shows all of the important natural resources of the Mohammedan world (twenty-two in number), ranging from live stock and cereals to minerals of every description. Out of the total of twenty-two items there are but four that have any significant development today, phosphate, manganese, tin, and oil. There is a fifth, coal, that may have considerable development though no real importance in relation to the rest of the world. The table deserves close study, for it reveals in the clearest possible light the extreme scarcity of those resources upon which modern industry rests, that is, resources necessary for the waging of modern war.

The disposition of the four resources which occur within the Moslem world in significant amounts neutralizes the value of even these limited advantages. The *phosphate* is found exclusively in French North Africa, where escape from European control, without any question of access and development, depends entirely upon control of the sea. The *manganese* is produced in Georgia, and its control by a Mohammedan power is chiefly important as a means of withdrawing a valuable commercial product from an enemy rather than through its use by a Mohammedan power. The *tin* is produced exclusively in the region of the Straits Settlements in southeastern Asia; and here again both development and transportation, which are indispensable to the use of the deposits, are determined by control of the sea. Added to that is the distance and the precarious nature of the routes by which it could be made available even if

it remained in Mohammedan hands. The *oil* has a wider distribution; but the main center is at Baku in the Caucasus, and practically all of the production up to the present time has been consumed in Russia. It does not affect the modern industrial powers to an important degree except as it supplies a need which spares their own reserves in time of peace. In time of war the withdrawal of the Baku supplies has no vital relation to the stakes of a controversy. In view of this layout of mineral resources and the lesser effects which the accompanying table discloses, it is clear that sustained warfare in a modern sense is entirely out of the question in so far as it is supported by the technical skill and the resources of the Mohammedan world itself.

Naturally this is far from saying that war cannot be long sustained upon the border of that world. Until traffic in arms and munitions is strictly controlled it will still be possible to barter such resources as a given country possesses for the means of waging at least guerrilla warfare that is likely to tempt an opposing power to send armed forces into the desert. The drain of such continued warfare is enormous in view of modern army standards of living and pay, which are in marked contrast to the standards of living that prevail as a rule among Mohammedan populations. It is not victory or defeat that is the critical issue with the invader but the expense of maintaining a military force and the protests of the taxpayer at home, who in all cases desires that his government shall take every step to foster commerce without risking war.

A Policy of Marginal Control

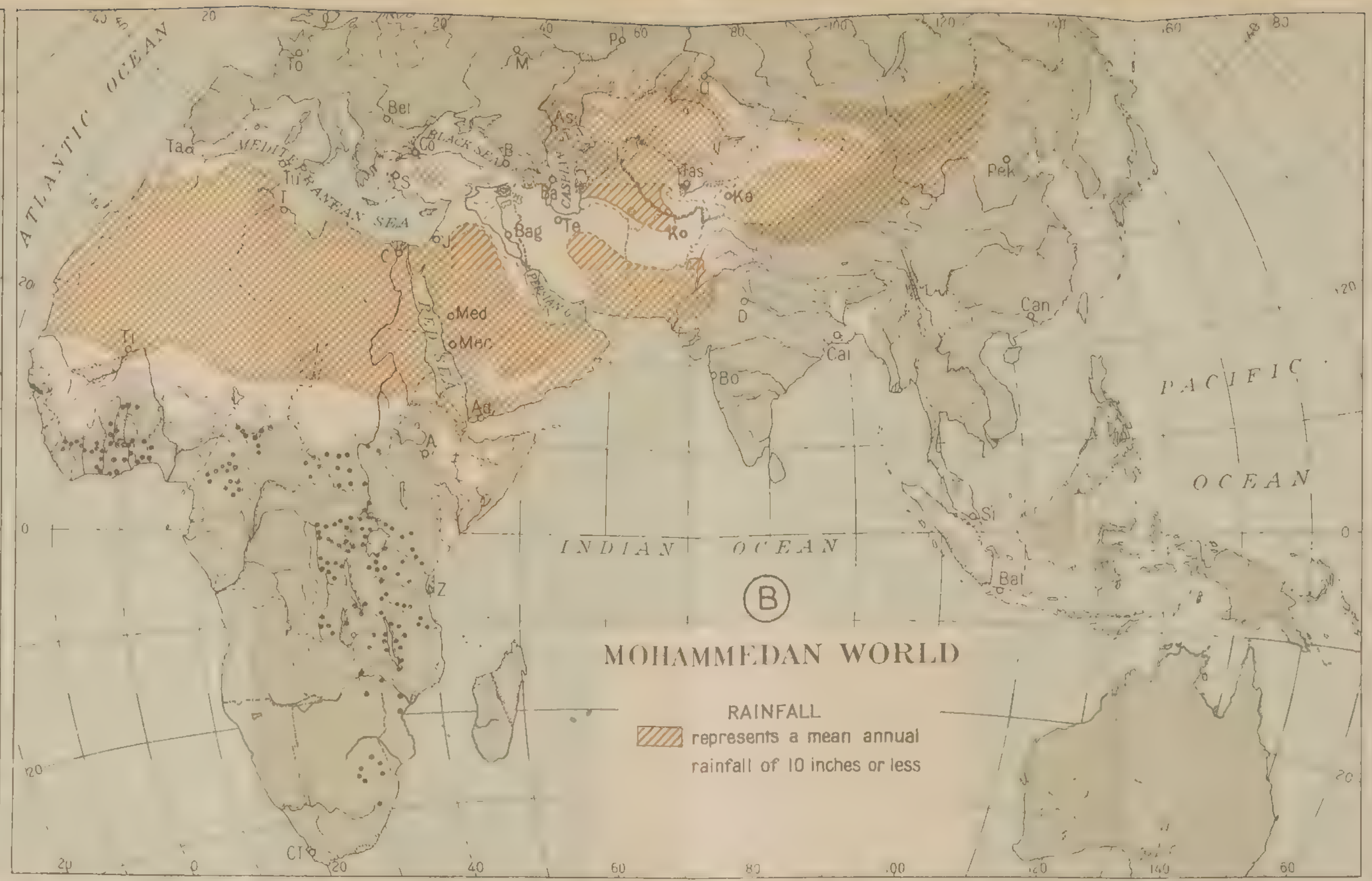
The political geography of the Mohammedan world appears to indicate a definite line of action on the part of contending powers. It would seem to be a sound policy to leave the Mohammedan world to itself so far as possible; but, above all, if force must be exercised, to exercise it only in strategic regions of high productivity or at strategic points where special sustaining resources like oil, phosphates, and tin may be developed. While this has been the line of general historical development, it is by no means a line that has been closely followed. Of all the powers that have dealt with the Mohammedan world probably that of the British Empire represents the most intelligent use of military and naval force in support of a national policy. We may fairly designate England's acts as representing a *policy of marginal control*. It is not a widely extended force that England has sent repeatedly into the Anglo-Egyptian Sudan but a small force directed toward a minimum number of objectives and withdrawn at the first opportunity. The British force in Egypt has always been too small to satisfy the military and naval critics of the government. In Mesopotamia England has controlled the outlets and a very small number of strategic points, and her latest proposal is to evacuate the country as soon as a new general treaty with Turkey has been ratified. In lightening the burden of occupation

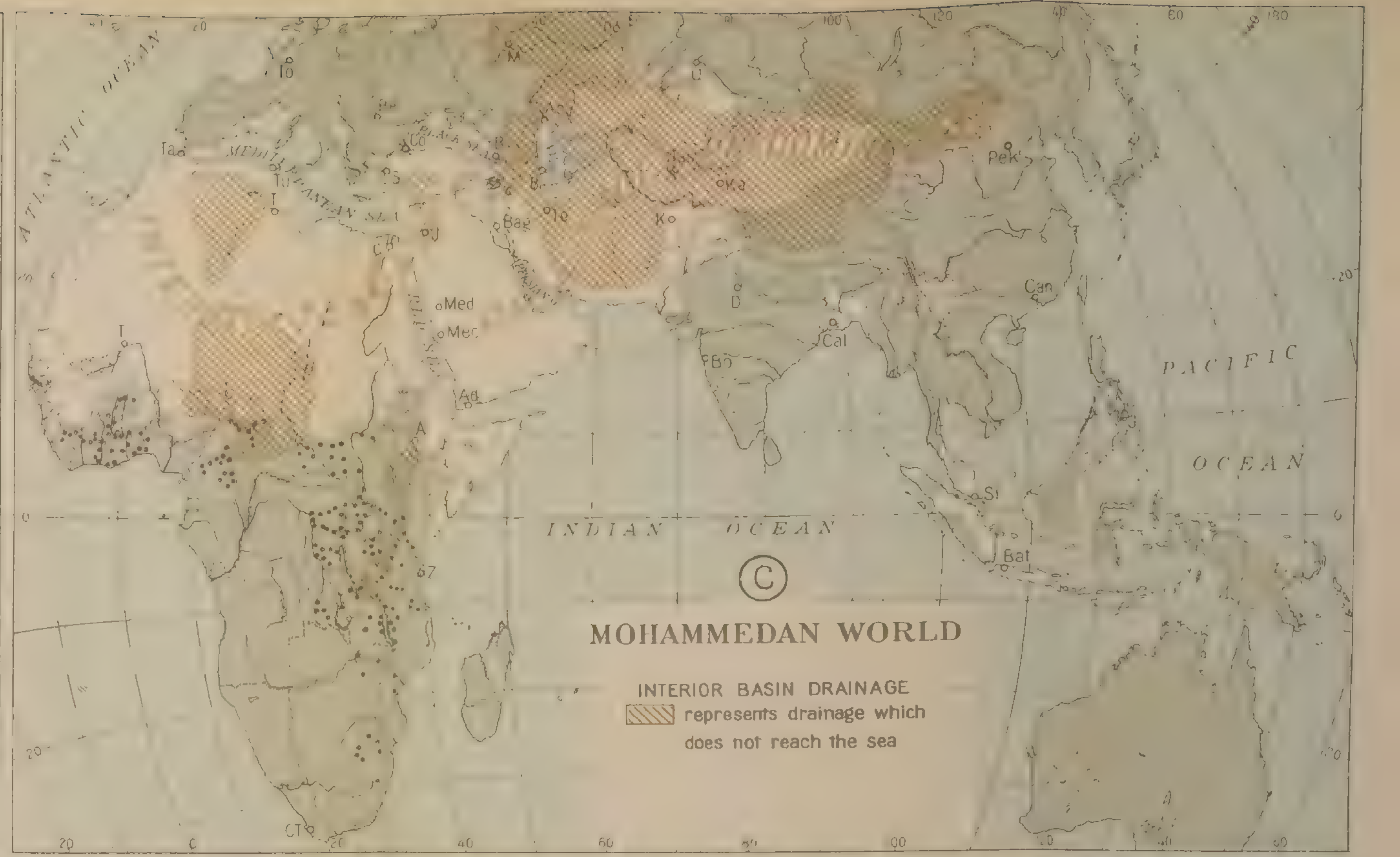
in Mesopotamia she has resorted in the last few years to airplane control of distant villages and to the disciplinary effects of bombing expeditions at points of active resistance. In Anatolia her ships of war have appeared repeatedly at the several coastal gateways, and marines have been landed there to attain only the nearest objectives to be held for the briefest possible time. In northwestern India there has been a constant interplay of negotiation and diplomacy on the one hand and the exercise of a minimum amount of military force on the other—a situation that has been maintained for nearly two generations. It is always touch-and-go between the French and British military and naval forces and the Mohammedan forces opposed to them. Hejaz was created during the war under the aegis of the British, and its control is vitally related to the exercise of naval force in the Red Sea.

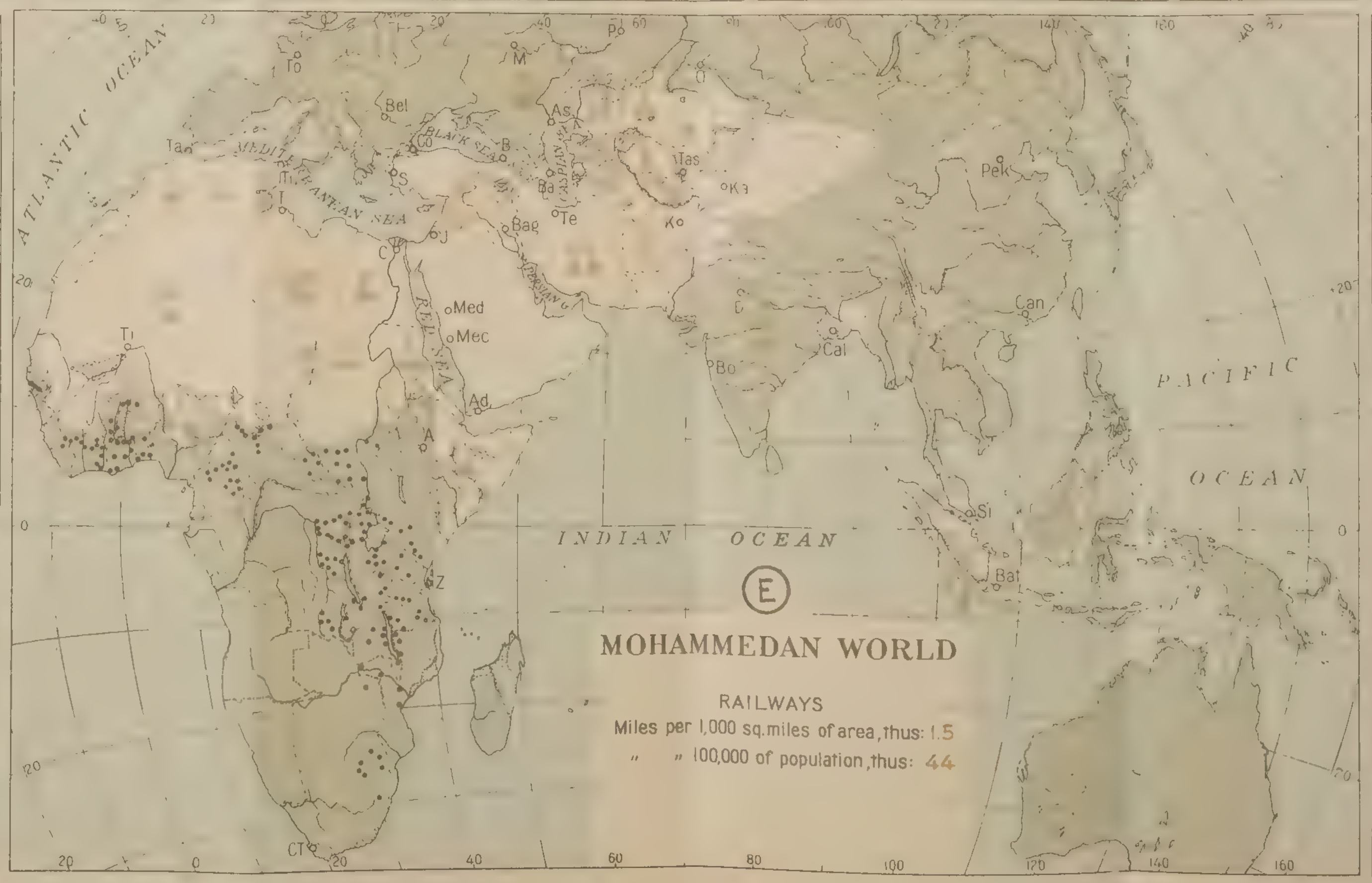
A review of the physical geography of the Mohammedan world and of relatively successful British policy in relation thereto reveals in a clearer light the unique position of Constantinople and its surroundings and makes clear how grave appears the issue to British eyes. Not only is Constantinople a focus of Mohammedan interest of such outstanding strength and significance that some form of control by western powers must be guaranteed; it is also a marginal point which under no circumstances could again be left as an unrestricted base of attack against the Christian world. Though the land area sustaining the city has been enlarged northward and westward as far as the Maritsa River, it is under limited control on account of the unfortified or neutral zones both along the European boundary and on the shores of the Bosporus and Dardanelles. To no small extent this prevents the exercise of military force in Europe and the equally dangerous exercise of diplomatic power should Europe be still further torn by internal strife.

The policy of marginal control of the Mohammedan world is one that would appear to require the most intensive study not only from the standpoint of strategy but also from the standpoint of national budgets. There may exist wide differences of opinion as to the question of control in any form at all, but once control is set down as a *sine qua non* it would seem that there could be little difference of opinion as to the narrow limits within which that control should be exercised. For there is not only the teaching of history, there is also the whole of modern experience during the past century, during the World War, during the past four years, to indicate that Mohammedan populations have in their geographical environment an ally of such power that expensive modern war would ruin the nation that attempted to oppose itself thereunto.

If we look for concrete illustrations of the principles to which we have alluded we find them thickly sprinkled upon the map. The cost of the French military expedition to Damascus and the occupying force in Syria is adding an overburdening weight to the already terrible burden of France. When confronted with the Turkish terms at the second conference of Lausanne France threatened to send additional troops to the support of the force in Syria, and there is no doubt at all that she could do this; but when







The Geographical Review, Vol. XIV, No. 1, 1924, Plate I

and how would the cost of the expedition be met? There are no resources within French territory that could possibly sustain them for any length of time, and the Turk can afford to wait; he can even afford to let his land and his people be wasted for a considerable length of time to gain his diplomatic objectives. His recovery will be rapid; the loss of financial power and the wrecking of her credit might well be a permanent disaster to France.

Italian experience offers a close parallel to that of the French and also to that of the British in Mesopotamia, Italy's gains in Libya in the war with Turkey (1911–1912) were held at great cost during the World War when the restless Senussi occupied the hinterland and extended their operations to the oasis of Siwa near the Nile only to meet defeat at the hands of the British. Since the armistice of 1918 Italy has pursued a policy of conciliation; and, finding the task of occupation and actual government an altogether impossible one, she temporized with the head of the Senussi, signed a treaty with him, invited him to Rome, conciliated the Moslems of Albania, and in short reoriented her entire Moslem policy to the end that she might have peace and engage in constructive enterprises as an alternative to continuous war. Her latest step is most illuminating. Early in 1922 there was opened at Bengazi the Cyrenaic parliament. A cousin of the King, the Prince of Udine, read the speech from the throne, which was translated into Arabic. Sixty-eight of the sixty-nine deputies were present, and almost all of them belonged to the Senussi confraternity. Fifty-four of the deputies had been elected through suffrage devices of their own; seven had been appointed by the Italian government, and eight by the head of the Senussi. Only two members of the parliament are Italians. Shortly after the meeting of the parliament the Italian government announced that self-government had been granted to Tripolitania. In short, limited and qualified control, a high measure of self-government, yet actual control of the country's assets and trade—these are the means of achieving the results that intelligent and economical administration require as a basis for reasonably lasting peace.

The local marginal successes of Mohammedan populations have been chiefly on the part of Turkey, the largest political unit in the Mohammedan world and situated on that corner of Europe farthest removed from the great industrial centers of the continent. The distance from London to Constantinople by sea is as great as that from London to New York. From Paris to Constantinople overland—and there are three mountain systems on the way—is as far as from St. Louis to Querétaro, far beyond the Mexican border. At first this looks altogether favorable for the case of the Mohammedans. But after absorbing these facts our balance of judgment will be restored only if we closely estimate the effect of physical geography and character upon political unity within the Mohammedan world itself. First in importance is that persistent sectarian division which from Mohammed's time down to our own has thwarted every leader who sought Mohammedan solidarity. By this we mean not merely the broad division between Sunnis and Shiahs but the large number of minor sects

that thrive in every quarter of the Mohammedan world. A common working program has been out of the question whether in the field of religion or that of politics and government. This conclusion is supported not merely by the events of the past ten years but by thirteen centuries of history. Ibn Saud's followers hate and fight the Hejazi as fiercely now as ever; the border of the "fertile crescent" of Syria is still raided by the nomadic Arabs, though they profess equal devotion with the settled farmer to the precepts of the Prophet; the question of the Caliphate is as little advanced toward definitive solution as when it first arose; the suggestion that there may be a union between the millions of blacks in the Sudan with the Kirghiz of Turkestan or even the less-distant Bedouin is an altogether fantastic one; and equally fantastic is the implication that any combination of units has the technical skill, the resources, and the physical layout that furnishes any basis whatever for aggression on a great scale. European disunion alone furnishes an opportunity for striking effectively in critical marginal situations and at critical times.

MALTA: AN ANTHROPOGEOGRAPHICAL STUDY

By L. H. Dudley Buxton
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The student of human history will find many remarkable things in Malta. The ancient remains are megaliths of a unique character. There has been a change in the human type since Neolithic times, and perhaps strangest of all is the great density of population—in round numbers about 2000 to the square mile—supported on a rock where the soil seldom exceeds a few inches in depth. Various problems of an anthropogeographical nature raised by these phenomena have presented themselves to the writer while engaged on an ethnological expedition (1920–1921) to the island[1] and during subsequent working up of the material collected. The object of this paper is to propound these problems in the hope of stimulating contributions towards their solution.

The Physical Setting

The Maltese archipelago consists of the island of Malta itself with an area of 95 square miles, Gozo with an area of 25 square miles, Comino and Cominetto, which with several rocky islets lie in the channel between the two larger islands, and the small island of Filfola which lies southwest of Malta. The group is situated almost in the middle of the Mediterranean, about 60 miles south of Sicily and 180 north of the African coast. An elevation of the sea bottom of 50 fathoms would connect the islands with Sicily, but a bridge with Africa would not be established until the sea bottom were raised 200 fathoms. The shallowest seas, however, lie to the west. It is wrong, therefore, to describe Malta as the remains of an ancient land bridge: it is rather the craggy bastion of a pier of such a bridge. There are indications, to which we shall return later, which suggest that the sea had not broken through the land bridge when the island was first inhabited by man. The depth of 50 fathoms is one which deserves consideration, as it has been suggested that since the close of the last glacial period and the consequent freeing of vast masses of water there has been, possibly in conjunction with other tectonic movements, a general relative elevation of the sea of 50 fathoms. It seems not improbable that today the island is slowly sinking under tectonic movements in progress.[2]

A bathographic map of the Mediterranean shows that the islands occupy what may be termed a strategic position between the two great basins of

[1] Cf. L. H. Dudley Buxton: The Ethnology of Malta and Gozo: *Journ. Royal Anthropol. Inst.*, Vol. 52, London, 1922, pp. 164–211.

[2] Professor W. H. Hobbs (The Maltese Islands: A Tectonic-Topographic Study, *Scottish Geogr. Mag.*, Vol. 30, 1914, pp. 1–13) has briefly noted evidence in favor of recent movements of both subsidence and elevation.

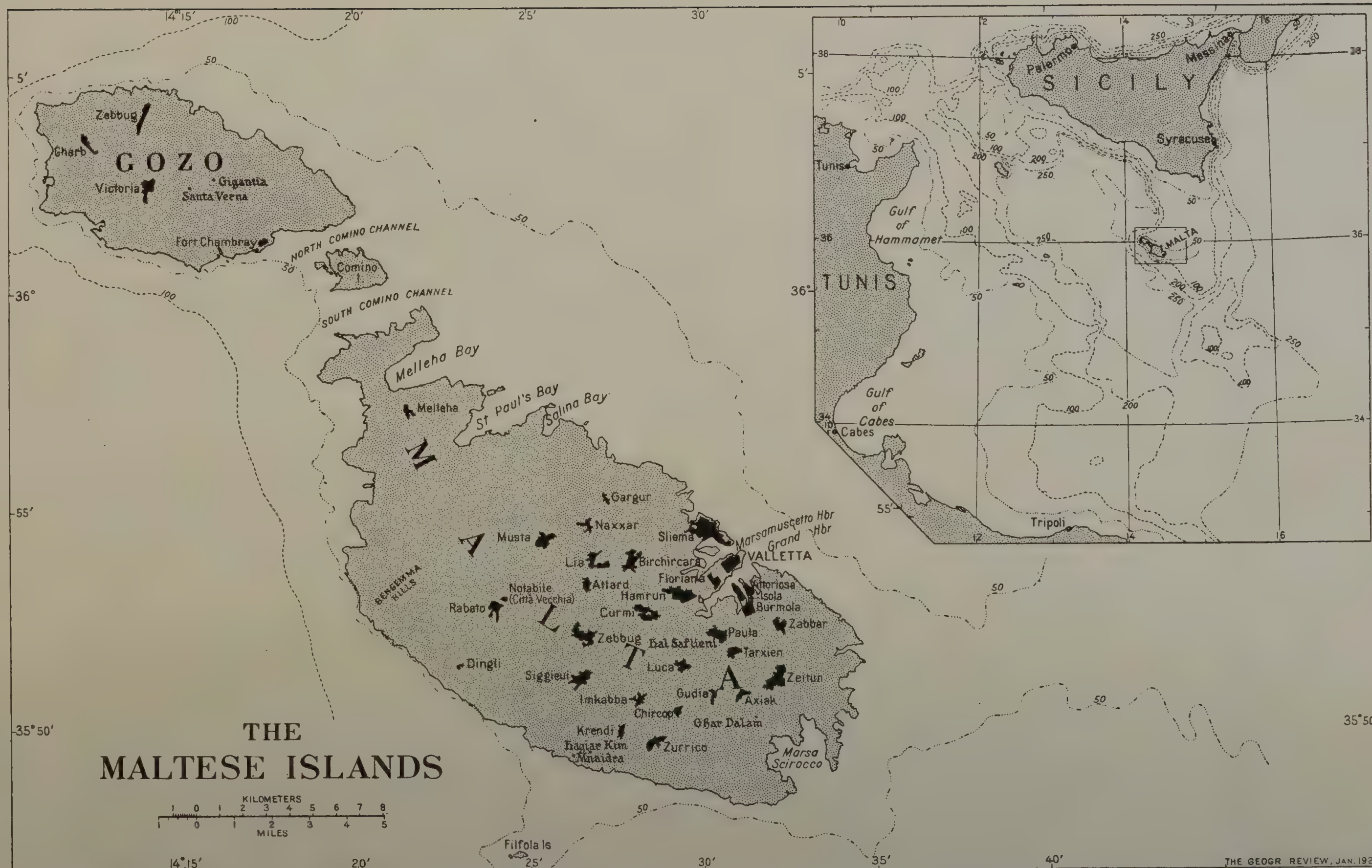

FIG. 1—Map of Malta and Gozo showing the chief settlements of today. Important archeological sites are indicated in antique lettering. Scale 1:300,000. Inset is a map showing the situation of the archipelago with reference to the European and African shores of the Mediterranean and the basin of that sea (scale 1:9,000,000). Depths are in fathoms.

that sea. I am informed by seamen that St. Paul's landing on the island was not the result of mere chance; for a small boat, more or less adrift but being carried westwards, would in all probability hit the island as it passed through the narrows between Sicily and Africa. It may be to such causes that Malta owes the eastern element which is so strong in her population.

Rock Structure

The rocks of which the island of Malta is built are chiefly Tertiary.[3] The underlying structure is Lower Coralline Limestone. This rock only appears on the surface where the overlying strata have been cut through by the action of torrential streams. Overlying the Lower Coralline and forming the greater part of the surface of the island east of a line drawn roughly north and south through the slope below Città Vecchia is a globigerina limestone. Out of it walls innumerable are built, and everywhere it pierces through the thin layer of soil. It weathers easily, and the surface soil is largely formed by its disintegration. Denudation of the area appears to have been, geologically speaking, comparatively recent. The valleys all end abruptly, suggesting that their former course lay in strata that have now disappeared. The oldest human remains of which we have extensive relics, which I shall show later belong to a period that may be conveniently termed Malta Local Neolithic, are to be found in this (the southeastern) part of the island, a fact the more remarkable as water-bearing strata are here entirely absent, and the *weids*, as the characteristic canyons are termed locally, are more or less dry for the greater part of the year.

To the west, including the magnificent bastions of Città Vecchia, the surface rock is Upper Coralline Limestone under which lie greensand and blue clays and marls. The three latter, however, seldom appear on the surface except on the hillsides and in one or two isolated spots where they have been exposed by denudation. Clays and marls constitute an impermeable layer which gives rise to perennial springs and, where it outcrops, forms the most verdant part of the island.

It might have been thought that so rocky a surface would be unfavorable to man, but apparently it is to the disintegration of the limestones that Malta owes her remarkable fertility and the fact that it is possible to raise several crops a year on so scanty a surface. This suggestion is due to Sir John Murray, who disproved the belief current from the sixteenth century that the island was naturally a barren crag to which all the soil had been imported.[4] He showed that continual crumbling of the rock provides a dressing very rich in phosphates and that the land, therefore, does not become exhausted as so shallow a soil might be expected to. Thus, and not

[3] A convenient summary of the geology of the island, with map, is given in F. R. C. Reed: The Geology of the British Empire, London, 1921, pp. 7–14.

[4] John Murray: The Maltese Islands. With Special Reference to Their Geological Structure, *Scottish Geogr. Mag.*, Vol. 6, 1890, pp. 449–488.

through the importation of soil, may be explained a fertility that has been proverbial at least from the time of Ovid.

Quaternary deposits are more frequent than has hitherto been supposed and probably occur along nearly all the *weids*. They are of course of the greatest importance in tracing the history of man in the island, and it is to be hoped that all of them will be carefully examined for paleoliths. These deposits are, however, difficult to discover because many of them are overlain by a pan of stalagmitic nature. The surface appears to be covered by a hard rock which on a cursory examination looks anything but recent. In places this pan is bare and sterile, but in a country where every square inch of soil is jealously guarded and cultivated it is hardly possible for the scientist to start blasting operations on the hope of finding elephant bones or paleoliths. This rocky covering of the soil is of the greatest economic importance, and it is possible that at places like Benhisa gap and elsewhere a judicious removal of the stalagmitic accretion by high explosive or other means might reclaim valuable land. Professor Myres has suggested to me an interesting parallel from the eastern Mediterranean. Strabo in describing Aegina says that the people are like ants, they go into holes in the ground and bring up soil from underneath which they spread on the surface of their fields. There can be little doubt that the ancient geographer was referring to similar Quaternary deposits concealed under a stalagmitic surface.

The whole of the island is tilted from south to north and falls very abruptly on the southern side; some of the loftiest parts of the island are quite close to the sea on the south, from which they are only separated by a picturesque and fertile undercliff, whose scenery forms a pleasant contrast to the rest of Malta. The north coast is more shelving than the south. The less denuded parts of the island rise abruptly to the west, crowned on the edge by the magnificent bastions of the old city, Città Vecchia. From the summit the watcher looks down over the most thickly populated part of Malta and over that part which as we have said contains practically all her antiquities. The tilt of the island to a large extent screens the south coast; but most of the rest of the southwestern part of the island is visible, and the contrast in scenery shows very clearly the contrast in geological features. To the west lies the range of the Bingemma Hills which rise to a height of over 700 feet and form the highest part of the island. At their foot and practically at right angles to the main axis of the island there is a fault in the rocks usually known as the "Great Fault." There are also a series of smaller faults parallel to it and others parallel to the southeast coast, the latter of which suggest that the island at one time had a very much greater area than at present. The whole surface is cut by small canyons to which the local name of *weid* may be conveniently applied because of distinctive features. They normally end abruptly and are usually dry, though they sometimes contain three feet of water or more in a spate. They continue seawards and form small fiords.

Climate

The climate may be summarized very briefly. Two factors dominate it, the surrounding warm seas and the winds, which except in the more westerly part are very little interrupted in their passage over the island. One of the most unpleasant and at the same time most characteristic features of the Maltese climate is the sirocco, which, after having been dried and warmed in its passage over the Sahara and moistened in the strip of sea between Malta and the African coast, envelopes the island in humid heat. The mean annual temperature is 66° F. The mean annual relative humidity on an average of seven years is 79 per cent. The hottest month is August, whose mean temperature is 78° F., and the coldest is February with an average temperature of 53° F. The mean annual rainfall is 22.6 inches, with a normal precipitation on 81 days. For three months in the year there is little or no rainfall, the return for June and July being practically nil and that for August only 0.16 millimeter. We may summarize, then, the conditions in Malta and say that the climate is hot and moist with a low rainfall not evenly distributed over the year.

Vegetation[5]

The traveler cannot but be struck by the fact that in spite of the intensive cultivation there is an abundant wild vegetation generally of a xerophytic character and including few flowering plants which are not annuals. *Centaurea crassifolia*, which grows on crags in the Weid Babu and in Gozo, is the only endemic species; but many plants having a wide distribution elsewhere are limited to small areas on the island. The myrtle is rare, and few shrubs of any size exist. The flora, generally speaking, is most akin to that of Sicily; 94 per cent of the Maltese species are found in that island, 91 per cent in Africa, and 90.50 per cent in the Levant. The commonest tree is the carob, but olives and numerous orange groves are cultivated. One of the villages, Zebbug, is called, I am informed by Professor Zammit, after the olive. If this etymology is correct one would be inclined to believe that olives were formerly cultivated to a greater extent. The most common plant in Malta at present is *Oxalis cernua;* it is a native of South Africa and is said to have been introduced at the beginning of the nineteenth century. It is usually known as Karsa or Haxixa ta t'Inglisi, "the English Plant." As a weed of cultivation it has ousted every rival and meets with little opposition; even the goats, who eat everything else, will not touch it. The only places where it does not appear to be common are either uncultivated spots or the undercliff on the south side of the island. The effect of the

[5] A very full account of the vegetation of Malta with a complete list of plants discovered there and, in the case of phanerogams, their location will be found in "Flora Melitensis nova," by S. Sommier and A. Caruana Gatto (Florence, 1915). An extensive bibliography includes references on the history, geology, and geography as well as the botany of the island. A useful summary of the general conditions is given by S. Sommier in *Nuovo Giornale Botanico Italiano*, Vol. 23 (N. S.), 1916, No. 3.

introduction of this plant by man is only comparable to the introduction of the tame goat in the Mediterranean. I am informed that it has now appeared in Crete, where also it will presumably carry on its depredations.

History of Man on the Island

With this setting before us let us consider the history of man in Malta.[6] Very early human occupation has been claimed for the island by the discovery of remains attributed to Neanderthal man. The sole evidence is that of a tooth found in a cave in the Weid Dalam which has been declared by Keith to belong to a person of that race. If we are right then in associating the earliest remains of man with dwarf hippopotamus and the three species of pygmy elephants all of which appear to be akin to *Elephas antiquus*, he originally lived in the island when it was connected with the mainland of Sicily and Africa. The Weid Dalam cave where these remains were found appears to have gone through the following physiographic changes. There is an upper terrace, now quite denuded, and a second terrace which contains the cave and which shows signs of scoring of at least two distinct water levels. Through this second terrace a deep narrow gorge has been cut. It would appear to have been made subsequent to the period when the hippopotamus flourished, as many of the bones exhibit distinct traces of wearing by water; it has been filled up by various deposits, and until these deposits have been systematically examined it is hardly possible to determine whether the different water levels in the second terrace represent different stages of the same elevation or whether subsidence followed by elevation has taken place.

Mediterranean Man in Malta

Few relics confirming the presence of man at this time have come to light at present; but, as we have suggested above, there remains a number of Quaternary deposits yet to be explored. We have so far no traces either of Paleolithic or of a pure Neolithic culture in Malta. At a much later period, which I have described as Malta Local Neolithic, we have abundant traces of man's handiwork in the large megalithic monuments of Tarxien, Hal Saflieni, Mnaidra, Hagiar Kim, and elsewhere. Their culture is too advanced and the style of the pottery is such that, quite apart from other grounds, it is impossible to place them early in the Neolithic period; and, although no traces of metal have been found, they probably belonged to what is known elsewhere as the Chalcolithic period. Of the relative date of this period we cannot speak here.[7]

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[6] For references to the literature see the bibliography accompanying the author's paper "The Ethnology of Malta and Gozo" (footnote 1).

[7] We think that possibly Professor Zammit is inclined to place it a little early (Pure Neolithic).

These people were akin physically to the Neolithic population of most of Europe. They have left us carvings of their domestic animals at Tarxien; and from these, as well as from bones, we know that they kept oxen, sheep, dogs, goats, and pigs. To judge from the number of bones on this site these animals must have been plentiful; whether we owe their presence to sacrifice, the exigencies of the table, or to other causes, the mere mass of bones is a significant fact. It is difficult to judge the number of the human inhabitants. Here again we have a great mass of bones in an ossuary at Hal Saflieni. There are many tons of material, and Professor Zammit counted in one cubic yard the knee caps of over 150 individuals. An ossuary is a bad place, however, from which to estimate the size of any population, especially since bones seem to have been brought from all over the island; but in any case they appear to point to a large population or a long period of years during which the ossuary was in use.

As far as our evidence goes at present, man of this period worked out his own salvation on lines which cannot be closely paralleled elsewhere. Most of the monuments give little indication of facts relevant to our purpose, but they point to a closer connection with Africa than any other region. Their distribution is important. They are limited to the older rock areas and do not occur in the west of the island. Although denudation of the Upper Coralline is in progress, our evidence would suggest that the land surface at this period was not unlike what it is now, although we cannot speak of its extent. The same types of megalithic remains are also to be found in Gozo, so that their limited distribution in Malta is all the more puzzling. How long the megalith builders inhabited Malta we do not know, and it is as difficult to trace their end as their beginning.

Change in Population Type

There are indications of a change of climate in certain sterile layers in the strata of the monuments, which suggest that at least at one period the island was much desiccated if not an actual desert. There is no suggestion at present, though later excavators may find it, of the destruction of the older civilization by barbarian invaders. It is possible of course that it was so destroyed. In any case the monument builders were so overwhelmed that not only did their culture disappear but, more extraordinary, their physical type. We shall return to this point later; at present it is sufficient to say that their successors seem to have belonged to a very different stock. The older peoples had belonged to the Mediterranean race; their successors are certainly akin to the Armenoid race. No radical changes have taken place in the population since that time, although certain developments have occurred which seem to be of importance.

Occupation by an Armenoid People

In the eastern Mediterranean, where the racial elements are not dissimilar, a great diversity of individual type exists and always seems to have

existed, at least from the beginning of the Bronze Age. Almost everywhere we find that any group of people show physically wide divergencies from the average of their group, and often, though this is a different matter, neighboring villages are significantly different from each other. With one or two important exceptions the earliest inhabitants seem almost everywhere to have been of Mediterranean stock. The Armenoid invaders came in and dominated this stock without apparently anywhere exterminating it. In the west for the most part Mediterranean man held his own and especially in southern Italy and Sicily. In Malta, however, this does not seem to have been the case, the older inhabitants apparently having had little part in the later population. Who these invaders were it is difficult to determine. It seems that they must have come by sea from the east, either directly or more probably by way of the north coast of Africa where, however, their physical type is almost nonexistent today, certain localities being excepted. Bertholon and Chantre, relying on the evidence of crania from the hypogeum at Hal Saflieni, have stated that the Maltese belong to the same race as the inhabitants of the coast of Africa opposite Malta; and the fact that since Bronze Age times this similarity has ceased to exist is all the more striking because of the striking resemblance between the populations of Tripoli and of Sicily shown since Neolithic times.

As far as can be seen the Armenoid type of man, who first came into Malta with bronze, has developed what might be called an island sub-race, which possibly contains some Mediterranean elements but generally speaking conforms to the Armenoid type. That this sub-race should have persisted and developed is remarkable both because of the geographical position of Malta and also because of her subsequent history during which, as we hope to show, the island was subject to influences seemingly sufficiently potent to alter the population type in the same way as they altered the culture.

Cultural Connections with Carthage and Rome

During the long period which follows the Bronze Age in Malta there is a cultural connection with Africa rather than with Europe. Punic influence was paramount, but it is difficult to estimate what man did to the island at this time. The principal traces of his occupation are numerous rock-cut tombs scattered over most of the area. There are only slight traces of definite Greek influence. Perhaps the greater fertility of Sicily prevented colonization, or more probably the population was already too large to offer openings for new settlers. The wars between Rome and Carthage made Malta a place of greater importance geographically than had previously been the case, and at the close of the second Punic war (218 B. C.) it was ultimately absorbed in the Roman dominions. We are accustomed to speak of the Roman period, but Romano-Maltese would sum up the situation more clearly. There is evidence of considerable activity on the island; the villas are luxurious, the mosaics beautiful, and the carvings on the catacombs suggest flourishing burial guilds. Cicero's references to the island

also suggest that it was in a prosperous condition. St. Paul's visit has been the subject of considerable doubt, yet it seems extremely probable that he was actually there; although the inference drawn from the use of the word "barbaroi" by the writer of the article on Malta in the 11th edition of the Encyclopaedia Britannica, viz. that they were neither hellenized nor romanized and therefore Phoenicians, seems to be straining the meaning of a commonly used word which simply means "not Greek".

In 177 A. D., after Malta had long ceased to be of any importance strategically, it was granted practical autonomy by being made a *municipium*. Nearly two hundred and fifty years later the island became part of the Eastern Empire, to the peoples of which the Maltese were certainly more akin than to those of the Western Empire.

Arab Influence

Historians suggest the inroads of barbarians; but their presence must have been temporary, for it would appear that when the Arabs conquered the island in 870 they found a Byzantine garrison in occupation. It is a curious point that the Moorish invasion actually came not from Africa as might have been expected but from Sicily. No special reference is made by Arab historians to the occupation of the island, and there are no archeological monuments of any importance belonging to this period.

How far the Moorish invasion affected the culture is a matter on which philologists are more competent to speak. There can be little doubt that the modern Maltese tongue is closely akin to Arabic, despite some writers who have declared it to be "undoubtedly Phoenician" without, I believe, having a knowledge of the latter tongue! There are of course numerous words of Italian origin; this could hardly be otherwise, but the main foundations appear to be similar to Arabic. We have unfortunately no clear evidence as to how long Maltese has been spoken; it has only recently been reduced to writing with adoption of the Roman script. In any case Arab influence was not sufficient to alter the religion of the people, and they remained Christian throughout; so that the question of language still needs further elucidation. In most cases where the Arabic tongue has been introduced it has been closely associated with religion; the absence of the written word may have helped to cause the dialectical difference that Maltese at present shows from Arabic.

During the succeeding period, if we may so term it, the island was of little importance. In 1090 Roger of Sicily captured it with a few men at arms and knights, and it was annexed to the crown of Sicily and followed its varying fortunes. The history of this time is of no great interest to our purpose, for Malta was an appanage of the crown and was not infrequently granted as a fief to court favorites. The Normans exterminated such Moslems as there were in the island. The Normans do not seem to have been numerically powerful and on the whole allowed the native population to continue their occupations without interruption, in fact apart from ruling the island they probably affected it but little.

Under the Knights of St. John and Later History

In 1530, however, Charles the Fifth granted the island to the Knights of St. John of Jerusalem. Malta again became an important strategic base. The first move of the Knights is significant. The old capital Medina, or Città Notabile (Città Vecchia), of the Kings of Sicily is situated inland. The site is admirable as a residence. The town is raised above the plain, and the beds beneath it ensure as good a water supply as can be found in the island. The Knights, however, had long ago ceased to function as cavalry and had become essentially a sea power. They therefore fixed their home on the sea in the Byrgo above the Grand Harbor.

Although it was evident that the challenge to the Turk implied in the occupation of Malta by the Knights must ultimately be accepted, the attack on the island did not come for thirty-five years. When it came the Knights, owing partly to their bravery and the determination and personal courage of their Grand Master, La Vallette, and helped partly by the mistakes of their enemies, were able to hold their own. It is significant that even in England under Elizabeth so great an importance was attached to Malta as an outpost against the Turks that prayers were offered in the diocese of Salisbury for the success of the Knights.

It is to this attack that Valletta owes its origin. The rocky hill on which it is built had been occupied by the Turks during their attack and was a vantage point not to be neglected. The importance with which Malta was regarded by the Christian Princes as an outpost against the infidel was more than exceeded by the views of the Grand Master. La Vallette with unfailing purpose pushed on the building of the new city on Mt. Sceberras but did not live to see it completed. He was buried in a little chapel where he had been wont to pray and meditate while superintending the work, the first inhabitant of the city called after his name. The elaborate fortifications built by La Vallette and his successors still exist, and the *auberges*, practically colleges, where the Knights lived are a permanent tribute to their genius as builders. The island was never attacked again until it was occupied by Napoleon in 1798 when the last Grand Master failed to live up to the great traditions of his order. It was taken over by Great Britain in 1800 and formally attached to the British Crown in 1814. Since the war it has again been given rights not unlike those which it enjoyed as *municipium* under the Roman Empire.

In dealing with the historical aspect of the problem we have been concerned chiefly with alien rulers; even when during the tenure of the Knights Malta was practically an independent power, her rulers were collected from all the noble houses of Europe. The Maltese themselves were not in control of their own fortunes. The island cannot at present grow enough wheat to support its population. As early as 1567 a tax was levied on imported wheat —an indication that even then an insufficient quantity was grown. It is impossible to estimate how far the island was self-supporting in still earlier

times. It can hardly be argued that the number of bones in the hypogeum at Hal Saflieni indicates necessarily a large population; but, owing to the distinctive nature of the culture, it is probable that in ancient times it was self-supporting. Water must always have been a difficulty. The Knights made and enforced an order that every house should have a cistern attached to it and the hypogeum owes its discovery to the making of such a cistern in modern times. In the time of the Knights, in order to provide an adequate water supply for Valletta, Grand Master Alof de Wignacourt constructed an aqueduct from the hills to the west over the dry limestone plateau to Valletta. In spite of these difficulties the population of Malta today is very prosperous and, until the last census, showed every sign of increasing. The actual figures are of interest.

Estimates and Censuses of Maltese Population

In 870 A. D. 3000 Greeks are said to have been killed and 3614 women and 5000 children sold into captivity. While these figures are obviously unreliable, they do at least indicate a large population. In 1530, 15,000 is the estimate made by Boisgelin[8], but Miége[9] suggests the higher figure of 29,659. After the attack of the Turks in 1566 the total is said to have dropped to 10,000. In 1582 the emissary of Pope Gregory XIII stated that the population had numbered 20,000—obviously a rough guess. In 1632 the census figure is 50,113, and thirty-five years later 53,000. In 1741 the island is reported to have contained 110,000 souls, which had increased by 4,000 in 1798. The figures for Malta and Gozo in 1826 are said to be 119,736; but this figure is an overestimate, and the first reliable figure is that published in 1828 where the population is definitely given as 115,945.

It is unnecessary to follow in detail the increase during the last century. In 1881 the total population of the two islands was 149,782. Twenty years later it had increased to 184,742 and by 1911 stood at 211,564, of which Malta claimed 188,869. The figures for 1921 are 189,697 for Malta, about 2000 per square mile, and 22,561 for Gozo, about 900 per square mile. The density in the southeastern corner of Malta is, however, much greater than would appear from these figures; for, if the island be divided along a line west of Gargur Naxaro, Musta, Notabile, Rabato, and Crendi, the areas east and west of such a line would be almost equal in size, but in 1911 the western (rural) area contained only 5737 inhabitants whereas the eastern area (suburban and urban) had the large number of 183,132. This is all the more interesting because, as we have already said, practically all the neolithic remains are to be found in the latter area, showing that the centers of population have not altered appreciably since Neolithic times. A considerable part of the population is urban; about one-fourth reside in the towns of Valletta, Floriana, Vittoriosa, Senglea, and Burmola with nearly one-third more in the vicinal "suburban"

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[8] Louis de Boisgelin: Ancient and Modern Malta, 3 vols., London, 1804; reference in Vol. 1, p. 107.
[9] M. Miège: Histoire de Malte, 3 vols., Paris, 1840; reference in Vol. 1, p. 154.

area. In spite of the advances that have been made in public health and especially in the organization of infant welfare, the change in the population since 1911 has not been appreciable—only an increase of 694, whereas in the previous decade the increase had been 26,822.

The extreme density of population in Malta is relieved to some extent by emigration. From April 1, 1920, to March 31, 1921, the total of emigrants amounted to 6186. The total since the conclusion of the war is 11,787, of whom 3838 have returned. The outward movement was directed in large measure to the United States (now practically stopped by the quota under the Restriction Act). There is notably a Maltese "colony" in Detroit. Many go also to the Mediterranean countries, chiefly France and northern Africa: there are large Maltese contingents in eastern Algeria and Tunisia.

An examination of the census figures shows that most of the foreigners in the islands have come from Italy and Sicily, as might be supposed. The figures for 1911 give 1848 foreigners in the islands; 122 came from Africa, of whom all except 3 came from Egypt, Tripoli, Tunis, and Algeria; 978 from Sicily; 409 from other parts of Italy; 75 from Greece (the number of women exceeding that of men in all these cases); and 11 (males) from "Asia." The majority of the foreigners, therefore, in all probability came from places where the Mediterranean race is dominant. The whole history of the island would suggest a close relation with northern Africa[10] and Italy. In spite of this fact, however, the population of Malta has not returned to its original racial affinities but has continued to represent the Armenoid type of people who apparently brought bronze into the island. Why this outpost should have survived is not clear at present. There is evidence to show that these people or their kinsmen did penetrate into the Mediterranean, and isolated examples of their skulls are found west of Malta;[11] but in this region, except for this one archipelago, they never seem to have really established themselves. There have been certain changes in their physique since their first appearance in Malta, but on the whole these changes have not been great.

We have so far been working on the assumption that there is a real difference between the Armenoid and Mediterranean types. This is a convenient assumption and one that is of great value for working purposes. It is, however, by no means a sure hypothesis. Certain schools of thought would find a point of dispersion for the one in Turkestan and for the other in Africa, while more recently it has been suggested that roundheads originated not in Asia but in central Europe. The question of difference of racial stocks does not really affect the arguments of this paper. Our main thesis has been to show (1) that at least in some areas a definite change can come over a people even though geographical conditions do not seem to change and (2) that the converse is often true, that it is remarkably difficult to

[10] There have at various times been negroes in the island as slaves, and I have seen a number of skulls which certainly belonged to negroes.

[11] W. L. H. Duckworth: Sardinia, *Zeitsch. für Morphol. und Anthropol.*, Vol. 17.

oust a people once established in a locality. During the course of our inquiry we have had occasion to review the curious succession of cultural influences which may be brought to bear on a single place. The whole may be conveniently summed in the following table.

Table I—Maltese Cultural Influences

Type of Culture	Direction Whence It Came	Remarks
Neolithic	Local (?)	Mediterranean Man
Bronze	Eastern Mediterranean	Armenoid Man ousts Mediterranean
"Phoenician"	North Africa ? Aegean	The name is unsatisfactory
Punic	North Africa ? Aegean	
Roman I	216 B. C. Italy	
Roman II	177 A. D. Italy and local	
Roman III	395 A. D. Eastern Empire	
Arabs	870 A. D. North Africa; Near East	Extent of influence uncertain
Normans	1090 A. D. Italy and the West	
Knights	1530 A. D. France, Italy, and the West	
Turks	1564 A. D. Near East	Unsuccessful attack
France	1798 A. D.	
Great Britain	1800 A. D.	

GEOGRAPHICAL CONDITIONS OF WATER POWER DEVELOPMENT

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The modern use of water for its motive force depends not only on its weight as in the old mill wheels but on pressure of water conveyed by conduit. This is very recent. It was only in 1869 that the first hydraulic power plant was installed in the northern French Alps near Grenoble; and from this usage of waters arising in Alpine glaciers and snows originated the picturesque term "white coal"—*houille blanche.* In 1883 the experiments of Marcel Desprez on the electrical transmission of water power, also conducted in the neighborhood of Grenoble, opened up the present varied possibilities of the utilization of white coal. This was the beginning of the hydro-electric industry, which thus dates back scarcely 40 years. In this short space of time it has, however, taken on a prodigious development and has become one of the great economic facts of the modern world. We shall here examine the geographical conditions involved—the physical and economic circumstances which have influenced the establishment and expansion of the industry—and shall take in specific illustration the countries exhibiting the most remarkable progress therein, the United States and France.

The Physical Conditions

What are the prime factors in the exploitation of hydro-electric force? From the physical standpoint there are two, susceptible of combination in a variety of ways—water and slope. The pressure of a certain quantity of water falling down a slope puts in motion a turbine. The greater the quantity of water available, and the steeper or longer the slope, the more energy is generated. Nothing simpler could be imagined. The most favorable conditions for the hydro-electric industry will then be realized in countries of pronounced slopes, that is in mountainous regions, which at the same time are well watered, regions of humid climate. On this basis the Bengal slopes of the Himalayas and the flanks of Cameroons Mountain should be the most favored parts of the world in respect of water power resources.

But this simple concept needs some elaboration. In the first place, if the *quantity* of water is a factor of prime importance so also is what one might term the *quality*. By it we mean regularity of regimen. A river with marked variation in flow is of inferior value; for utilization must be based on minimum flow or power production will be irregular. Obviously it is possible to correct irregularity of flow by the creation of storage reservoirs, and this has become a prominent feature of the industry. However, such works may

prove too expensive for an enterprise in which the high cost of installation is already a handicap.

The two essential factors, water and slope, may be considered as mutually compensatory in a large measure. If in the one instance a small quantity of water falls from a great height it will yet be capable of generating considerable force. Inversely on a slight slope a great volume of water can effect the same result. Thus there are two well defined types of power-producing streams—of high fall and small discharge, of low fall and large discharge. It should, however, be noted that if the power generated in the two cases is equal the cost of production will not be the same; for the high fall can be equipped and maintained at less expense. Advantage thus rests with slope over volume, and in hydro-electric development it may be said that slope is a factor of more decisive importance than water. Let us now see in what parts of the world these conditions are best realized.

Advantage Offered by Glaciated Regions

On the whole it would appear that glaciated regions best respond to these requirements; and this is confirmed in detail. Such regions are usually rich in water. Glaciation calls not only for a low temperature but more imperatively for abundant precipitation. In Quaternary times central and eastern Siberia, where precipitation then as now was scant, was unoccupied by glaciers, while they capped the mountains of the equatorial zone. In America glaciation profoundly affected Labrador and eastern Canada, while in the same latitude of the southwestern prairies its effects are lacking because of the difference in precipitation. Now the distribution of precipitation today is similar to that of Quaternary times. Regions which were occupied by the great Pleistocene glaciers today receive abundant precipitation and are characterized by well filled watercourses.

As regards the other factor, slope, glaciated regions are likewise well suited for hydro-electric development. Glaciation has contributed to this end in a variety of ways. In the mountains tributary hanging valleys offer abrupt descents to the major valleys, a condition which reduces the labor of installation to a minimum. To this specific cause may be attributed the precocious development of water power in the French Alps. Many alpine valleys are also characterized by *verrous*, transverse rock barriers over which the streams descend by cascades. Moraines may also constitute an obstacle, less durable without doubt but long capable of sustaining a break in slope. But the chief influence of morainic deposits is indirect. By obstructing river beds they have turned streams out of their former channels: the new superimposed courses in a youthful stage almost always exhibit stretches of steep gradient and broken slope. This is the case for instance in many sections of the Drac in the French Alps; in North America it was operative in the origin of Niagara Falls.

At the same time the streams of glaciated regions are likely to be of uniform or easily regulated flow. This advantage arises in the first place out

of the character of the water supply. Regions where temperature was low enough for glaciation in the Quaternary still receive a part of their precipitation in the form of snow. Melting of the snow, or even better of the ice if accumulation takes this form, contributes to the maintenance of stream flow in the warm season when it would otherwise tend to be irregular and scant. Thus in France the alpine torrents, largely fed by melting of the snows, have a more regular regimen than the rivers of the Central Massif where the heavy rains of summer do not prevent this season from being a period of extreme low water. But the uniform flow of the rivers of a glaciated country is primarily due to the character of the topography. The creation of natural dams, as we have noted, tends to the accumulation of water in natural reservoirs. Glaciated countries are *par excellence* countries of lacustrine hydrography. This is the case with northern Russia, Finland, Scandinavia, Scotland, Ireland, the Alps and Pyrenees, New England, Canada, the Cascade Mountains, the southern Andes, and the New Zealand Alps. Now lakes act as remarkably efficient regulators of flow: and rivers emerging from them have a constancy of discharge that renders them well adapted to hydro-electric development. It will suffice to instance the Rhone issuing from Lake Geneva or the St. Lawrence from the Great Lakes. These natural conditions can be improved upon artificially by heightening the barrier impounding the waters and thus increasing the storage capacity.

Glaciated regions thus offer all the favorable physical circumstances for hydro-electric development—water in abundance, slopes abrupt and broken, uniform and easily regulated flow. If economic conditions permit they will become producers of white coal.

Circumstances in Non-Glaciated Regions

This does not mean that hydro-electric industry cannot flourish save in glaciated regions. It can; but in general only through qualification by some exceptional circumstance. Almost always one of the important factors that we have enumerated will be lacking. Non-glaciated mountains usually suffer from insufficiency of precipitation or too great seasonal variation in distribution. This is the case with the greater part of the Mediterranean chains and the lower slopes of tropical mountains where division of the year into wet and dry periods imposes such irregularity on stream flow as to render it difficult of utilization. Rivers of the equatorial regions, on the contrary, have much water well maintained throughout the year; but the very volume of water has permitted them rapidly to approach base level, while the amount of alluvial material carried further militates against utilization. In temperate regions rivers rising in non-glaciated mountains are also marked by lack of uniform flow; almost always they are very low in summer. As we have said, there are exceptions. The most remarkable is that of the equatorial rivers where to already favorable circumstances of abundant and steady flow some tectonic accident has added steepness of gradient. Thus the great river Congo, whose entire middle course is in the equatorial zone,

is characterized in its lower course, between Stanley Pool and Matadi, by a series of rapids of total fall of 800 feet capable of generating a force estimated at 100,000,000 h. p. Then there is the case of the Upper Nile, which shortly after its emergence from the regulating reservoir of Lake Victoria forms the Murchison rapids, uniting three favorable factors—slope, volume of water, uniformity of flow. The height of the Victoria Falls on the Upper Zambezi creates great hydro-electric potentialities on a tropical river of irregular flow. Similarly the steep western slopes of the Deccan invite development in spite of the irregularity of stream flow dependent on monsoonal rains.[1] The eastern Andes of Peru and northern Bolivia have a heavy rainfall through the year and offer physical conditions of a high order counteracted at present by the extreme isolation of the region that has been the main factor in retarding economic development. The rivers on the southeastern flank of the Appalachians offer the advantages of the fall line. The *porogs*, or rapids of the Dnieper in the Ukraine, representing an abrupt break of slope in the Russian plain, are capable of furnishing more than 100,000 h. p., although the stream flow is far from uniform.

But it is apparent that these are exceptional cases: the general conditions where they obtain are entirely otherwise. While the Congo is utilizable, thanks to the Yellala rapids, that other great equatorial river, the Amazon, is unutilizable for lack of slope.[2] On the eastern slope of the Deccan the gradient is insufficient to compensate irregularity of flow. The Zambezi below the Victoria Falls is of no interest hydro-electrically. In the southern Russian plain only the Dnieper rapids are useful; no other sections of this river or of the Don or Volga offer opportunities for power development.

This rapid survey of hydro-electric conditions in various parts of the world brings us to the conclusion that save for exceptional cases favorable factors are to be found much more generally in glaciated regions. Here the industry has developed. It remains to be seen if the economic factor is in accord with this distribution.

The Economic Factor

The economic factor has as great weight in the geographical distribution of the hydro-electric industry as the physical factor. The first problem encountered is that of means of access. The labor of installation in its many elaborate details demands sufficiently good means of access to the chosen location. Some fine natural sites in the heart of the mountains have been passed over for others less advantageous in themselves but more accessibly situated. Climate may exert an influence to the same end. Some sites otherwise favorable are blocked by snow six months of the year. The short season of accessibility means that work must be carried on over a greater

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[1] Compare the projects discussed in R. S. Cree Brown: Recent Engineering Developments in Western India, *New Zealand Journ. of Sci. and Technol.*, Vol. 6, 1923, pp. 20-36.

[2] Some of the major tributaries of the Amazon have considerable potential power resources, for instance the Madeira with a 200-mile stretch of rapids above Porto-Velho.

length of time for capital to gain returns; and labor demands more remuneration, for working conditions are harder. Here enters in a psychological factor that cannot be ignored—the effect of living in a remote place in a region of wild and hostile nature. We know of a large plant in the French Alps where strikes are of very frequent occurrence: the attitude of the workers being largely due to the unfavorable location of the plant—in a deep, narrow, shut-in valley where the sun disappears for three months during the winter. In some instances the problem of ways of access is truly insoluble.

Significance of Power Transmission

Closely connected is the question of utilization on the spot of the power generated. It is advantageous that the energy obtained should be used as near the generating plant as possible. This also calls for ease of transportation for introduction of the raw materials of manufacturing and expedition of the elaborated products. Early in the history of hydro-electric development, when technical achievement was little advanced, it was necessary to take every possible advantage of favorable physical circumstances, and establishments using water power were installed in the interior of the mountains in situations not too well placed as regards communications. But progressive improvement has been made in this respect. Now the tendency is to place the manufactories on the periphery of the mountains. In glaciated mountains the industry has best scope for development if extensive plains are adjacent. In glaciated lowlands, such as the Laurentian region, where favorable sites abound the problem of communications enters in only in detail. In the French Alps it has long been clear that the disposition of the hydro-electric plants is intimately connected with the railroads. Yet a tendency towards modification is in progress in virtue of the possibility of power transmission.

The possibilities of power transmission modify somewhat the earlier controls over location of the industry. It is now possible to transmit power to great distances in the form of currents of high voltage and low intensity through the use of transformers. A current of over 100,000 volts can, for instance, be carried a distance of over 500 kilometers. But power cannot be transported beyond a certain limit—as yet scarcely beyond 500 kilometers. The problem is chiefly one of cost. Transmission involves a loss of 10 to 20 per cent; erection and maintenance of the lines is also expensive; whence a point is reached where costs of transmission exceed the value of the power transmitted. In the great project for harnessing the Rhone conceived in 1917 the cost of carrying the power 400 kilometers to feed the great plant of Genissiat at Paris proved nearly as great as the operation of the plant itself. To improve the transmission of power between the northern Alps and the Lyons region new lines were constructed, the cost of which was so great that it could only be borne by a combination of the several hydro-electric associations. Thus advantage evidently lies with those industries situated near the central power station.

More general in nature, common indeed to all industries, is the problem of labor. A region admirably dowered from the physical point of view but economically inactive is likely to remain unexploited. The glaciated regions of the far north, where conditions of life are hard and highways of transportation are far removed, are "empty of men." Northern Canada is in this case, and so is northern Europe; to a less degree the same is true of the Andes of southern Chile. Outside the glaciated regions in the favorable exceptions we have noted, similar economic handicaps may obtain. Along the lower Congo not only are formidable technical difficulties encountered, but, even if the potential 100,000,000 h. p. could be developed, one would not know what to do with it in this new country where industry of all kinds could scarcely make use of 10,000 h. p. In a less degree the falls of the Upper Zambezi suffer similar disabilities. The great falls of the Paraná and the Iguassù have remained undeveloped in part because of their remote situation.

Competition with Coal

Another aspect of the problem of the economic utilization of hydro-electric force is competition with coal. Countries which possess abundant resources of coal or even of lignite, capable of producing cheap electric power, are hardly interested in developing their water power potentialities even if these are considerable and favorably disposed. The northwest of Great Britain with its glaciated topography, its lakes, falls, and heavy precipitation offers most favorable physical conditions. The existence of the coal basins has discouraged hydro-electric development, and the British Isles only produce 200,000 h. p. from water power. As a recent analysis of the situation has said, "It would appear, therefore, that there is sufficient water power in the Scottish Highlands to meet a large part of the demands of industrial and municipal requirements in Scotland, but, on the other hand, it is doubtful if the cost after development and transmission to existing industrial areas would be less than the cost or power generated there at the pit-head."[3] Conversely the absence of coal is an incentive to development of hydro-electric resources. This is the reason for progress of the industry in the French Alps and in Italy. In eastern Brazil, in spite of the irregular regimen of the streams, about 150,000 h. p. is already developed for lack of fuel.

Thus for hydraulic electricity to be exploited on a large scale it is necessary that the producing stations be situated accessibly and that the power generated be utilized as near the stations as possible. M. Cavaillés has well expressed the characteristics of the two forms of energy: "L'une est sédentaire, terrienne, autochtone; c'est, a l'encontre d'une opinion trop répandue, la houille blanche. L'autre est nomade, maritime, cosmopolite; c'est le charbon de mine."[4] That the industry be paying and able to sustain

[3] Alexander Newlands: Water Power in Great Britain (with Special Reference to Scotland): Its Amount and Economic Value, *Journ. Royal Soc. of Arts*, Vol. 76, 1918, pp. 168–188.

[4] Henri Cavaillés: La houille blanche, Paris, 1922, pp. 202–203. This volume is reviewed elsewhere in this number of the *Geographical Review*.

competition with coal demands a regional market capable of using large quantities of hydraulic energy. Where are these economic conditions filled?

Regions Economically Favorable to Power Development

The countries of European civilization are obviously indicated. It is only there, if inclusion be made of Japan as an economic participant in this civilization, that exploitation of white coal has met with success. There the market is to be found: there are railways to be electrified; heat, light and power industries to be supplied; agricultural operations to be aided. The greater part of Asia; almost the whole of Africa; the Oceanic archipelagoes; a large part of South America, where the economic stage is low, are excluded, for the time being at least, from this form of activity.

Of the remaining regions there must be set aside those areas where the abundance of coal in relation to local industry has retarded use of water power, that is Great Britain, central Germany, and perhaps southern Japan. But coal can compete only when it is produced on the spot; that is when it does not have to bear the costs of transportation. It is noteworthy that on the French shores of the English Channel, where Welsh coal can so easily be imported, the hydro-electric establishment of Selune is flourishing, and other similar projects are planned. Proximity of the Newcastle coal field has not retarded water power development in Scandinavia.

From this general survey of factors governing the white coal industry we proceed to illustration of the operation of the several factors from the two countries where the industry has shown the most marked progress.

White Coal in the United States

The United States, with 9,000,000 h. p., leads the world in developed water power.[5] France, with 2,000,000 h. p., ranks third (after Canada) and holds first place for Europe. The water power development of these two countries illustrates remarkably well the interplay of economic and physical factors that we have described.

Of the total of hydro-electric power in operation in the United States in 1920 about 40 per cent was produced in the glaciated region of the north and east, 32 per cent in the glaciated mountains of the west, while practically all of the rest (20 per cent) was produced in a non-glaciated region—the eastern and southern border of the Appalachians.

The Northwestern Region

The glaciated region of the northeast is the old platform of crystalline rocks and primary deposits which form the Laurentian plateau and its borders; it also includes the northern prolongation of the Appalachians.

[5] Statistics for the United States from the World Atlas of Commercial Geology, Part II, Water Power of the World, U. S. Geological Survey, Washington, D. C., 1921.

Thus it presents two chief aspects: in New England a country of low mountains and hills with numerous watercourses of comparatively small volume; and the country behind, along the Canadian frontier, a more level region strewn with lakes and traversed by streams of considerable volume.

The watercourses of New England were the first in America to be used for motive power. In colonial days numerous water mills were established along their banks. They responded early to the advent of hydro-electric power for which they were well equipped by nature. Precipitation is abundant; glaciation has created many falls and rapids in the streams and numerous lakes. Economic conditions are favorable: the region has no coal; but industrial activity is intense, and energy requirements are large. Relief raises no difficult obstacles to communications; the falls are within easy reach of industrial towns. All factors concur to encourage the establishment of a great field of hydro-electric industry. The installations are widely distributed and mostly of moderate power, as would be expected from the numerous small streams and the early inception of the industry. However, the Rumford Falls, on the Androscoggin River, generate 51,000 h. p.; Turners Falls, on the Connecticut, 66,000 h. p. The total of 1,400,000 h. p. in New England, 15 per cent of that for the entire country, is devoted to woodworking, paper, cotton, and woolen industries.

Westward from the Hudson to the Dakotas (excluding the outlier of the Adirondacks) extends the region of the glacial plains. Relief is moderate: the height of the falls generally is small, and the rainfall is less than in New England. But these deficiencies are more than compensated by the existence of those great bodies of water—the Great Lakes, which, after the Congo, furnish the greatest reservoirs of hydro-electric energy in the world: this without counting the network of smaller lakes, swamps, and marshes. The watercourses draining these lacustrine areas carry considerable and regular volumes of water, while the existence of rocky or morainic dams or rapids in their superimposed courses offer suitable power sites. That of Niagara River alone, with 327 feet of fall between the levels of Erie and Ontario, has a potential capacity of 6,000,000 h. p. Economic conditions are extremely favorable. The country is populous; industry, agriculture, and commerce are all well developed; communications are excellent. In this region hydro-electric industry has taken on a marked development.

There are important installations on the Upper Hudson at Glens Falls and Spier Falls; on the Mohawk at Cohoes; on West Canada Creek; and on the southern tributaries of Lake Ontario. Four establishments on the American side of Niagara furnish 385,000 h. p. In Michigan, Wisconsin, and Minnesota the southern tributaries of the Great Lakes, the Muskegon, Au Sable, Grand, St. Joseph, Fox, and Chippewa Rivers, and St. Marys River connecting Lakes Superior and Huron are largely utilized. Au Sable River alone furnishes 64,000 h. p. Power here is employed for light and traction, the paper and wood industries, electro-chemistry, and mining. Finally, on the Upper Mississippi at St. Paul and Minneapolis, at Keokuk, Iowa, and at

a number of small centers are low falls of large volume. The plant at Keokuk, where a dam across the Mississippi gives a fall of 9.75 meters furnishing 170,000 h. p., is typical: the greater part of the power is transmitted to St. Louis. Flour-milling and woodworking industries share the power produced in this section with light and other public utilities.

In sum, this region of the glacial plains of the United States represents almost exactly 25 per cent of the total production of the country. With the New England States it is the region where water power has been most highly developed. Although it accounts for a quarter of the power now generated, the potential capacity is estimated at only 7.5 per cent that of the whole country. The discrepancy between these figures speaks eloquently for the operation of the economic factor. The case is otherwise with the glaciated mountains of the west.

The West

In the western mountains appears another factor, that of slope. Many summits attain elevations of over 10,000 feet, overlooking the high plains of Missouri or the Great Basin, while still more profound is the descent to the Great Valley of California. The gradient of the rivers in general is steep: in detail, glaciation has fashioned features suitable to hydro-electric exploitation especially by permitting construction of reservoirs to supplement water shortage, which is a serious consideration in the south and east of the region.[6] But as one proceeds west and north precipitation increases, even becomes heavy and with much in the form of snow. Physical conditions are thus more favorable than elsewhere. The potential capacity of this region amounts to 72 per cent, or nearly three-quarters of that for the entire country. Installed water power, however, amounts only to 32 per cent. Backwardness is evidently due to economic conditions. Relatively recently occupied, the western mountains are much less densely populated than the northeastern region: and so they will remain on account of the relief. Industry is less developed, communications difficult. It is true that coal is of limited occurrence, and there is this incentive to water power development; but the market for long will be smaller than that of the northeast.

In 1920 the west generated 2,900,000 h.p. from its streams. This production was very unequally distributed: it increased progressively with increase in precipitation. Insignificant in New Mexico, it amounted to 50,000 in Arizona, over 100,000 in Colorado and Utah, over 200,000 in Idaho. A great part of the power produced here, apart from public utilities, was for the needs of agriculture—pumping and irrigation. This use in agriculture is one of the distinguishing features of the hydro-electric industry in the west.

Farther north, in Montana, the energy generated exceeds 400,000 h. p., where are the great installations on the Upper Missouri and its tributaries, the Yellowstone, Madison, and Jefferson. At Great Falls alone 200,000 h. p.

[6] Mr. O. C. Merrill of the Federal Power Commission calls attention to another favoring circumstance in Oregon—"the great lava cap which holds precipitation in underground storage and thereby affords some of the best regulated natural run-off that we have in the United States."

is produced, which is used in the mines and foundries of the state and in traction on over 440 miles of the Chicago, Milwaukee & St. Paul Railway.

It is, however, in the three Pacific states that hydro-electric power plays its greatest rôle and has its greatest future. Here 2,000,000 h. p. is produced, of which 1,110,000 is attributed to California. Here are the steepest slopes, the most characteristic glacial accidentation, the largest water supply, the most important market. Here are the giant installations; one of 60,000 h. p. on White River, Wash., one of 160,000 h. p. on Big Creek, a tributary of the San Joaquin, supplied by a reservoir of 110,000,000 cubic meters capacity at 2000 meters altitude. Hydraulic power in the Pacific states is used for all purposes—lighting and traction, extraction and reduction of minerals, exploitation of the forest, watering and irrigation, manufacture of cement and paper, and in the metallurgical and electro-chemical industries.[7]

The South

Outside of the glaciated regions water power is largely exploited in the southeast along the Appalachians. It is one of the exceptional cases of which we have spoken. Although glaciation has not exercised its influence here, the physical factors are favorable in many respects. There are strong gradients from the mountains to the Piedmont while the Piedmont descends to the coastal plain by an abrupt descent, the famous fall line. Precipitation is heavy on the southeastern flank of the mountains, and the streams are of considerable size. However, uniformity of flow under a regimen approaching the semitropical leaves something to be desired. The region is well populated and has need of energy for its growing industries, metallurgical and especially textile. In one respect the region is exceptional. The presence of coal instead of retarding water power development has expedited it. The policy of combining carbo-electric and hydro-electric power resources bids fair to become a distinguishing feature of industry in the east of the United States. A recent report on the creation of a "Superpower Zone" of the region between Boston and Washington states that "a prime economic purpose should be so to conjoin the hydro-electric supply of power to the steam-electric supply as to produce a maximum of energy for a minimum investment of capital and a minimum operating expense, and at the same time to conserve the rapidly disappearing cheap fuels of the Appalachian coal fields."[8]

Commencing with Pennsylvania we find the McCalls Ferry plant on the Susquehanna producing 118,000 h. p., destined in large part for Baltimore. The chief centers, however, are in the states of North and South Carolina, Virginia, and Georgia, which generate 1,160,000 h.p., or 12.5 per cent of that produced in the country. There are the great installations on the Yadkin (Ba-

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[7] Cf. the table in H. M. Spink: Some Geographical Aspects of Water-power Development in Recent Years, *Scottish Geogr. Mag.*, Vol. 39, 1923, pp. 7–20.

[8] W. S. Murray and Others: A Superpower System for the Region between Boston and Washington, *U. S. Geol. Survey Professional Paper 123*, Washington, D. C., 1921; reference on p. 13. Abstracted in the *Geogr. Rev.*, Vol. 12, 1922, pp. 487–488.

din with 81,000 h. p.), on the Catawba (one of 90,000 h. p.), on the Tallulah (Tallulah Falls with 90,000 h. p.). The industry is rapidly developing in Alabama where 100,000 h. p. is produced on the Coosa; and there is an important series on the Tennessee, including the famous Muscle Shoals project, Tennessee already possessing installations of 220,000 h. p. The influence of favorable economic factors is seen in the fact that the greater part of the energy produced is employed in industry; 84 per cent in the South Atlantic States, in textiles, mining, steel and aluminum metallurgy, and various other manufactures. It is also noteworthy that to compensate lack of uniformity in stream flow recourse has been had not only to supplementary steam power but to an interconnection of the power systems—the lines being connected in such a manner that excess at one point can be distributed to supply deficiency elsewhere.

White Coal in France

The use of white coal is very unevenly distributed among the several regions of France. According to figures for 1922,[9] the Alps possess 55.4 of the total water power installed, the Pyrenees 14.5, the Central Massif 19, the remaining 11 per cent being shared by the plains and lower mountains.

The French Alps

The French Alps, especially the northern portion, are excellently endowed for the utilization of water power. The mountains are lofty, many summits exceeding 4000 meters while Mt. Blanc itself attains 4810 meters. Precipitation, thanks to the Atlantic type of climate, is abundant; some massifs in the northern Prealps receive as much as 4 meters a year. Snow fields and glaciers constitute important storage reserves for the drier season. Glaciation has molded the relief in an infinite number of favorable ways. Economic conditions are satisfactory. The northern Alps includes populous areas within and on its borders. Communications are facilitated by broad, deep valleys. On the borders of the region an extensive market is found for the use of white coal—to the north the industrial area of Lyons and St. Etienne, to the south Marseilles and the Côte d'Azur. Paris even is tending more and more to seek hydro-electric power from the Alpine streams.

Thus is explained the early development of hydro-electric industry in the region and the great strides it has made of recent years,[10] now producing 800,000 h. p. in the north, 300,000 h. p. in the south. In no region of the world is the degree of hydro-electric development expressed by power in relation to area so high. At the same time the uses to which it is put are extremely varied: lighting, traction, electro-chemical, electro-metallurgical, paper, wood, cement, and textile industries. The precocious flowering of the industry here as in New England meant scattering in small installations.

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[9] Raoul Blanchard: La houille blanche en France en 1922, *Rev. de Géogr. Alpine*, Vol. 10, 1922, pp. 609–624.

[10] For details see Raoul Blanchard: L'industrie de la houille blanche dans les Alpes françaises, *Ann. de Géogr.*, Vol. 26, 1917, pp. 15–41.

The largest plants in the Alps, those of l'Argentière on the Durance, Beaumont-Monteux on the Lower Isère, Victoire on the Upper Isère, do not surpass 50,000 h. p.

Installation in the Alpine region is characterized by the employment of what may be described as the *alpine technique*. It is based on the existence of exceptionally favorable physical factors which permit harnessing of the waters in a simple manner and at little cost. As slopes are steep and sharply broken and flow is abundant, the work of installation is reduced to a minimum; a low dam is sufficient to obtain a head of water, and the supply channel to the conduits is of short length. Expenses of maintenance also are not high. These advantages have popularized the use of white coal in the Alps and have encouraged its exploitation in other French regions. But the conditions obtaining in these other regions are distinctly less favorable, and in them adaptations have been necessary.

The French Pyrenees

The French Pyrenees, though less elevated than the Alps, are capable of furnishing ample water power. They descend precipitiously to the plains on their northern border. Precipitation is abundant, especially in the western section. Glaciation has characteristically eroded each valley into a series of steps down which the streams cascade, rendering installation easy. Though the mountains are sparsely populated, it is easy to transmit power to the plains where there are no obstacles to communication and where density of population permits establishment of industry. There is no competition from the presence of coal. These are the advantages. But there are drawbacks. Economically this part of France is far less advanced than the southeast: the demand for power is small. Even from the physical standpoint the Pyrenees are less favorable than one might imagine. The streams are of short length and their hydrographic basins of limited extent; hence the volume of water is generally small, while the feeble development of glaciers and snow fields means greater variation in stream flow. For long the industry was confined to small installations of less than 10,000 h. p. scattered even more markedly than in the Alps.

The necessity born of the war of obtaining more power led the Pyrenean industrials to seek a new type of installation. To compensate the small flow it was decided to look for a high head of water. This was available in the mountain lakes so numerous in the Pyrenees at elevations of from 1800 to 2500 meters. At the same time these lakes converted into reservoirs permitted regularization of flow. This solution by what may be termed the *Pyrenean technique* was costly, but it has given remarkable results. Thus are furnished the great plants recently erected in the basin of the Pique, of Eget and St. Lary on the Neste, and those of the *gave* of Ossan. Through these the water power production in the Pyrenees was doubled between 1914 and 1918, and today it surpasses 300,000 h. p.

The Central Massif

A similar transformation is in progress in the Central Massif, but the situation here is more exceptional. Here favorable economic circumstances have made use of very indifferent physical conditions by the employment of appropriate methods of installation.

The Central Massif has great need of its white coal. The region is densely populated, and industry has been long developed; coal is produced in insufficient quantity, and the plains surrounding the Massif to the west and north also have important energy requirements. In these mountains of limited area and low elevation, where the topographic form is characteristically of broad plateaus, communications are easier than in the Alps and Pyrenees.

But the streams are ill adapted to water power development. If the relief of the Massif favors communications its rivers on the contrary are deficient in volume, irregular in flow, and lacking in steep gradients. Although precipitation is fairly heavy it is considerably less so than on the Alps and Pyrenees; and there are no reservoirs of snow and ice to tide over the low water season of summer. Glaciation has affected the region to a slight extent only, and slopes are gentler and often regular. All these drawbacks arise from the low altitude of the mountains.

The first attempt at exploitation of water power resources here met with little success. The method employed so successfully in the Alps was adopted here as in the Pyrenees, but it could only be utilized in a limited number of particularly favorable sites. In 1914 there was only 100,000 h. p. installed. Again, as in the case of the Pyrenees, the war stimulated inquiry into methods of installation better adapted to natural circumstances. In consequence resort was had to the construction of big dams. By erecting high dams across the valleys reservoirs of hundreds of millions of cubic meters capacity were constructed, which in addition to regulating flow provided a head of water as high as the dam. But again, as in the case of the Pyrenees, the cost including expropriation of the land involved and building of the dams was high. From the middle of the war work was started on the great installations. Some of these on the Dordogne, the Cère, the Truyère, and the Rhone produce 40,000 to 80,000 h. p. and are the largest in France. From scarcely 100,000 h. p. in 1914 the figure of production has risen to 380,000 h. p. and thus surpasses the Pyrenees.

The great French regions of hydro-electric power production clearly show, then, the influence of geographical factors on the development of this industry. Their example also shows how, when necessity presses, special means can be devised to surmount the natural obstacles and turn to advantage the unfavorable factors. The special techniques thus employed are themselves facts of a geographical order, for they are adapted to particular conditions of relief, slope, transportation. With the variety of factors controlling its exploitation and the variety of solutions called for in adaptation to these factors the hydro-electric industry is a good example of human geography.

THE HISTORY OF GLOBES: A REVIEW*

By Eugen Oberhummer
University of Vienna

For centuries the globe has been regarded as a symbol of geography and of scholarship in general. Innumerable pictures and drawings from ancient and from modern times bear witness to this; but formerly the use of globes was of far greater practical importance than it is today. Magellan and the great explorers of the sixteenth and seventeenth centuries carried such instruments with them as aids in finding new paths through unknown seas. In the eighteenth century the chart, ever more and more improved, began to take the place of the globe, and no modern sailor would attempt to steer a course by the latter. Even in schools handier, more detailed maps and atlases have replaced the venerable implement of our fathers, now for the most part relegated to the position of an ornamental accessory to the library.

Modern globes serve merely to exhibit summarily our knowledge of the earth's surface or of the starry heavens; for them no claim of scientific originality or artistic perfection is made. In the age of discovery, on the other hand, globes were the result of critical reflection and recorded the successive steps in the progress of geographical knowledge. Many, especially the celestial globes and orreries, are works of the highest technical and artistic skill. Their history is a narrow but interesting chapter in the history of civilization—a chapter, however, which has not been written until our day. Pioneer work was done by Matteo Fiorini in his "Sfere cosmografiche"[1] and more especially for Italy in his "Sfere terrestri e celesti."[2] Of the former publication Siegmund Günther in 1895 gave a short but substantial abstract.[3] The first ample treatise dealing with the entire subject, however, is the work of Edward Luther Stevenson now under review.

We need not point to Stevenson's numerous publications on the history of cartography, more especially the early cartography of America, as testimonies of his competence; his new book in itself bears witness to this. Two magnificent volumes full of splendid illustrations narrate the history of globes from classical antiquity down to A. D. 1800. The last chapter, de-

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* Edward Luther Stevenson: Terrestrial and Celestial Globes, Their History and Construction: Including a Consideration of Their Value as Aids in the Study of Geography and Astronomy. 2 vols.; Vol. 1, xxvi and 218 pp.; Vol. 2, xii and 292 pp.; maps, ills., bibliogr., indexes. *Publs. Hispanic Soc. of Amer. No. 86.* Yale University Press, New Haven, 1921.

[1] Matteo Fiorini: Le sfere cosmografiche e specialmente le sfere terrestri, *Boll. Soc. Geogr. Italiana*, Ser. 3, Vol. 6, 1893, pp. 863–888, Vol. 7, 1894, pp. 121–132, 271–281, 331–349, and 415–435.

[2] *Idem:* Sfere terrestri e celesti di autore italiano appure fatte o conservate in Italia. Rome, 1899.

[3] Siegmund Günther: Erd- und Himmelsgloben, ihre Geschichte und Construction. Nach dem italienischen Matteo Fiorinis frei bearbeitet, Leipzig, 1895.

voted to "The Technic of Globe Construction—Materials and Methods"—is followed by a long and careful "Bibliographical List," a serviceable "Index of Globes and Globe Makers," and a general index. The illustrations are for the most part phototypes, partly after originals in the rich collection of the Hispanic Society of America.

The author has tried to gather a list of all references to existing old globes, but such a list could of course never be made absolutely complete for individual items. Thus, for instance, Stevenson could not be expected to have knowledge of certain globes in Vienna about many of which nothing has ever been published. This circumstance induced me to attempt the compilation of a catalogue of such globes as lay within my immediate reach. In a short time I was able to record forty-five globes or pairs of globes, upon which observations of importance could be made. Furthermore I am confident that my list will be extended ere long. As space will not permit consideration of all the details in the present review, the reader is referred for fuller treatment to my paper submitted to the Vienna Academy of Science,[4] quoted in the present article as "Alte Globen," with the serial number of the example to which reference is made.

The following critical remarks are not meant in any way to be prejudicial to the great merits of Stevenson's work. They are intended, rather, as an aid in the elucidation of particular points and to be of use, perhaps, in the event of the publication of a second edition.

Greek, Roman, and Arab Globes

Figures 5 and 6 of Stevenson's book (Vol. 1, pp. 7 and 9) are an interesting attempt at the reconstruction of the globes of Crates and of Strabo. Besides the discussion of the matter in the second edition of H. Berger's "Geschichte der wissenschaftlichen Erdkunde der Griechen" (Leipzig, 1903), now the fundamental treatise on the history of ancient geography, we may refer to the articles "Globen" by Boll, "Karten" by Kubitschek, and "Krates" by Kroll in Pauly-Wissowa.[5]

The marble celestial globe of the Farnese Atlas in Naples is not the only solid sphere that has come down to us from antiquity but merely the most important one. It is somewhat astonishing to find it illustrated (Figs. 7 and 8) after an old drawing of Passeri, 1750. Inasmuch as the statue is more important for its subject than for its artistic value, plaster casts of it are rarely found in archeological museums, but photographs were sold by G. Sommer in Naples; and a full description, with photographic views from all sides made from a copy in Vienna, has been published by G. Thiele[6].

[4] Eugen Oberhummer: Alte Globen in Wien, *Anzeiger Akad. der Wiss. in Wien, Phil-hist. Klasse*, Vienna, Dec., 1922., pp. 87–109.

[5] Paulys Real-Encyclopädie der classischen Altertumswissenschaft, new edit. by Georg Wissowa and others, Stuttgart, 1894–, Vol. 7, cols. 1427–1430, Vol. 10, cols. 2145–2150 (§§ 86–89 on globes), and Vol. 11, cols. 1634–1642.

[6] Georg Thiele: Antike Himmelsbilder, Berlin, 1898, pp. 19–42 and Pls. II–VI.

Thiele tried to show that the constellations were copied from the globe of Hipparchus, but this contention was disproved by Boll[7] and by Rehm.[8] Boll believes that the statue was made in the time of Augustus; in any case the date before 300 B. C. assigned to it by the astronomer Heis (1872) is not satisfactorily established.

In addition to the Farnese Atlas there exist a few other ancient marble globes, such as one with a diameter of 16 centimeters,[9] another with a diameter of 31 centimeters found in 1866 in the theater at Athens; and a fragment of a vase in the form of a globe in the Berlin Museum.[10]

A Roman fresco from Boscoreale near Pompeii, now in the Metropolitan Museum in New York, exhibits the outlines of a globe with meridians and parallels and is illustrated by Stevenson (Fig. 10). The coins and gems reproduced in Figures 11 and 12 remind us of the fact that from the time of antiquity the orb has been a symbol of world empire. Demetrius Poliorcetes appears to have been the first ruler who so used it, but afterwards we find it as a regular attribute of the Roman emperors and of their supposed successors of the Holy Roman Empire. Thus the *Reichsapfel* in the imperial treasury in Vienna with its intersecting ocean belts is probably a schematic copy of the quadripartite sphere of Crates.[11]

We have nothing to add to the careful chapter on the celestial globes of the Arabs, several of which appear now for the first time in photographic reproduction. Terrestrial globes of the Arabs and of the Christian Middle Ages before the Age of Discovery are unknown, though the beautiful picture by Nicolas d'Oresme, 1377 (Fig. 19), as well as much written evidence, shows that the idea of a spherical earth was not foreign even to the medieval period.

The Fifteenth Century

The oldest known terrestrial globe that has been preserved for us, and therefore the most interesting, is the *Erdapfel* of Martin Behaim dating from 1492. In dealing with this monument of unique significance, now in the Germanic Museum at Nuremberg, Stevenson's description[12] was much

[7] Franz Boll: Beiträge zur Ueberlieferungsgeschichte der griechischen Astrologie und Astronomie, *Sitzungsber. Bayer. Akad. der Wiss. zu München, Philos-philol. und hist. Classe*, 1899, Vol. 1, pp. 77–140; reference on pp. 120 *et sqq.*

Idem: Georg Thiele, Antike Himmelsbilder [review], *Berliner Philol. Wochenschrift*, Vol. 19, 1899, cols. 1009–1017; reference in cols. 1013 *et sqq.*

[8] "Hipparchos," Pauly-Wissowa: Real-encyclopädie, Vol. 8, cols. 1666–1682; reference in col. 1672.

[9] Described by Gaedechens: Der marmorne Himmelsglobus zu Arolsen, Göttingen, 1862.

[10] References by Thiele. *op. cit.*, pp. 42 *et seq.;* and Boll in Pauly-Wissowa, Vol. 7, col. 1429. See also the scholarly book of Boll, "Sphaera," Leipzig, 1903.

[11] For references see Eugen Oberhummer: Imperialismus: Das britische Weltreich und die imperialistischen Staatenbildungen früherer Zeit, Vienna, 1920, pp. 10–11. The statement of Karl Sittl ("Der Adler und die Weltkugel als Attribute des Zeus in der griechischen und römischen Kunst," *Jahrbücher für Classische Philologie, Suppl. 14*, 1885, pp. 1–51) that this symbol had already appeared on the darics or gold staters of the Persian kings seems to be erroneous. The sphericity of the earth was first revealed by Greek philosophers and was unknown to the Persians.

[12] Dr. Stevenson has described this globe in the pamphlet "A Description of Early Maps, Originals and Facsimiles (1452–1611): Being a Part of the Permanent Wall Exhibition of the American Geographical Society," Amer. Geogr. Soc., 1921. It may be added that another facsimile of this globe has been made for the Geographical Institute of the University of Vienna.

facilitated by the excellent publication of E. G. Ravenstein, "Martin Behaim" (London, 1908).

In the chapter on the great geographical discoveries wherein Behaim's globe is discussed there is a statement which we cannot pass over without criticism. The author attributes possibly too much weight to the opinions of Henry Vignaud concerning the correspondence of Columbus and Toscanelli (Vol. 1, pp. 52–57). The critical examination of the question by Hermann Wagner[13] and others seems to me to be conclusive, though the matter is still one in which freedom of opinion must be conceded. There cannot, however, be room for opinion in the statement that Constance is in Switzerland (p. 53). To be sure this charming old town is situated well on the southern shore of the lake which bears its name, but it has been a German free city since 1192 and was never a part of the Helvetian Confederacy. Since 1805 it has belonged to the grand duchy (now the republic) of Baden.

The Early Sixteenth Century

The early sixteenth century was the classical period in the history of globes. Then it was that methods of construction, drawing, and printing were developed. The progress of discovery is revealed in such precious documents as the copper globe of Laon (probably before 1500), the first printed globe gores by Martin Waldseemüller[14] (1507) in the Hauslab-Liechtenstein collection, the famous Lenox globe in New York (c. 1510), the Green globe in Paris (c. 1515), the globes of Johann Schöner in Nuremberg, and others. The gores known under the name of Leonardo da Vinci are more interesting by reason of their doubtful attribution to that great genius than for their inferior technique and scanty content.[15]

The problem of the globe in the collection of the Prince of Liechtenstein which Stevenson (Vol. 1, p. 75) calls the "mounted Hauslab globe," supposed to be a work of Johann Schöner or at least to be of common origin with the sketch of the world of the Nuremberg geographer, has now been cleared up by a fortunate discovery. During my review of the Vienna stock of old globes I obtained courteous permission from the Prince of Liechtenstein to examine the objects in his geographical collection preserved in his summer palace at Vienna together with the famous picture gallery. I was astonished to find a *pair* of manuscript globes, celestial and terrestrial, equal in size and equipment. No one had hitherto given any hint that

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[13] Hermann Wagner: Die Rekonstruktion der Toscanelli-karte vom J. 1474, *Nachr. Gesell. der Wiss. zu Göttingen, Phil.-hist. Klasse*, 1894, pp. 208–312; *idem:* Toscanelli's Brief und Karte v. J. 1474 vom Standpunkte der Geschichte der Kartographie, *Atti X Congr. Internaz. di Geogr., Roma, 1913*, Rome, 1913, pp. 1305–1308; *idem:* [note in] *Petermanns Mitt.*, Vol. 68, 1922, p. 135, note 586.

[14] As allusion is made to this globe in the "Cosmographia introductio" of 1507 (critical edition by F. von Wieser, Strasbourg, 1907) with the words *Totius orbis typus tam in solido quam in plano*, etc. (Stevenson, Vol. I, pp. 69 *et seq.*) I would assign it rather to this date than to 1509 when Waldseemüller published his "Globus mundi."

[15] Besides Stevenson's notes (Vol. 1, pp. 78 and 91) see my article "Leonardo da Vinci and the Art of the Renaissance in Its Relations to Geography," *Geogr. Journ.*, Vol. 33, 1909, pp. 540–569.

there was a celestial globe, and former visitors either had no knowledge of it or did not think it worth examining. No doubt the terrestrial globe is the more interesting. It is in an excellent state of preservation; the drawing is clear, distinct, and easily legible. Luksch's description of it,[16] on which all the further notices of Gallois and others are based, is only partial (western hemisphere) and gives but a general idea. A good photographic reproduction with the full legends is highly to be desired.[17] There is, indeed, no signature or other indication of the origin save the place name "Brixen" written in red ink like "Germània" and other more important names. The celestial globe is colored dark green; the stars and circles are in gold; the legends in black and hence not easy to read on the dark background. The system of graduation is that of the ecliptic with astronomical longitudes and latitudes, but the equatorial system is represented by the equator, tropics, polar circles, and colures. Turning the globe over and over, I found below the Tropic of Capricorn and parallel to the equinoctial colure the following inscription: *Hunc globum Imaginum fieri fecit Nicolaus Leopold Enipontanus Canonicus Brixinen. in gratiam R^mi et Illust^m Principis Domini D. Sebastiani Sperancij Presulsis Brix. Cla. dono dedit Anno salutis 1522.* "This globe of the constellations was made by order of Nicholas Leopold of Innsbruck, canon of Brixen, in honor of the most Reverend and Illustrious Prince and Lord Sebastian Sperantius, the most eminent (probably *clarissimi*) Bishop of Brixen: presented A. D. 1522." Sperantius (Sprenzer) was sovereign bishop of Brixen from 1521 to 1525. The name of the canon seemed at first doubtful, as some of the letters in the original are injured, but with the aid of my colleague, the historian Oswald Redlich, President of the Vienna Academy, I was able to identify the name in the voting list of Sperantius, 1521, and of his successor, George of Austria, 1525. Apparently the canon, soon after the election, took the opportunity to court the favor of the new lord in the ecclesiastical principality. Whether the terrestrial globe, on the other hand, was finished before or after 1522 is still uncertain, though the picture of a caravel west of South America would seem to indicate vague knowledge of Magellan's expedition. The words *fieri fecit* show that Leopold was the originator but not the real worker of the globes. The maker's name rests in obscurity. Schöner's globes, perhaps, served him as models.

A few remarks may be inserted here regarding the globes connected with Magellan's journey. I wonder that Stevenson makes no mention of the excellent monograph of Jean Denucé bearing on this subject.[18] In regard to the globe said to have been brought by Magellan to the Spanish court, Denucé (pp. 177 *et seq.*), it is true, has no more to say than Stevenson (Vol. 1, pp. 81 *et seq.*). But on another controversial matter Denucé's paper

[16] J. Luksch: Zwei Denkmale alter Kartographie, *Mitt. K. K. Geogr. Gesell. in Wien*, Vol. 29, 1886, pp. 364–373.

[17] For further details see my "Alte Globen," No. 6.

[18] Jean Denucé: Magellan: La question des Moluques et la première circumnavigation du globe, *Mémoires Acad. Royale de Belgique, Classe des Lettres et des Sci. Morales et Polit.*, Vol. 4, Brussels, 1911.

throws light. This is concerning the globe gores found in 1884 in Munich, now, as I learn from Stevenson (Vol. 1, p. 87), in the New York Public Library. On these gores the sailing route of Magellan and del Cano is delineated for the first time. They were attributed by Wieser[19] and later by Henry Stevens, Coote, Gallois, Günther, and Kretschmer, to Schöner (1523). Harrisse and Nordenskiöld disputed this ascription. The question was discussed anew and decided in favor of the former attribution by Denucé (pp. 386 *et seq.*) whose opinion I followed in my "Magellan."[20]

It was a curiously retrograde step in the cartographic evolution of the sixteenth century that, despite Magellan's journey, the greatest nautical achievement in history, the idea of a broad connection between Asia and America and doubt of the independent character of the New World could arise once more. Kretschmer has examined this circumstance in a large way,[21] and Stevenson gives us further details about it from such globes of the period as the gilt globe in Paris (c. 1528), the Nancy globe (c. 1530), and Schöner's and Vopel's globes of 1533 and 1542.[22] Surely the peculiar globe gores of Alonso de Santa Cruz, 1542, do not show it, nor does it seem to be found on the globe of Gemma Frisius, 1530, concerning which, besides the short original publications of Walter Ruge, a chapter in a recent monograph on Mercator by H. Averdunk and J. Müller-Reinhard may be consulted.[23] This study, though in the Bibliographical List (Vol. 2, p. 221), does not appear to have been taken into consideration by Stevenson in his treatment of the work of Mercator (Vol. 1, pp. 124–135), otherwise so careful and rich in information. Stevenson is right in emphasizing (Vol. 1, p. 128; Vol. 2, pp. 205 and 208 *et seq.*) the technical improvements shown in Mercator's gores—truncated biangles with a circular polar disc—and in his delineation of rhumb lines.[24] The construction of the loxodromic rhumbs, curved on the globe of 1541, as straight lines on a chart comes near to corresponding with Mercator's projection on his famous map of the world of 1569. However we cannot go further and admit that Mercator was the inventor of plane maps with increasing latitudes. Two portable sundials of the Nuremberg cartographer Erhard Etzlaub, dating from 1511 and

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[19] F. R. von Wieser: Der verschollene Globus des Johannes Schöner von 1523, 18 pp., *Sitzungsber. Kaiserl. Akad. de Wiss., Phil.-hist. Classe*, Vol. 117, Abhandlung V, Vienna, 1889.

[20] Eugen Oberhummer: Ferdinand Magellan und die Bedeutung der ersten Erdumseglung, Vienna, 1921; reference on p. 32.

[21] Konrad Kretschmer: Die Entdeckung Amerikas in ihrer Bedeutung für die Geschichte des Weltbildes, 2 vols. (text and atlas). Berlin, 1892; reference in text, pp. 408–443, and in atlas, Pl. 18.

[22] See especially Vol. 1, pp. 109 and 114; and Figs. 49, 50b, and 56a.

[23] H. Averdunk and J. Müller-Reinhard: Gerhard Mercator und die Geographen unter seinen Nachkommen, *Petermanns Mitt. Ergänzungsheft No. 182*, 1914 (reviewed in the *Geogr. Rev.*, Vol. 7, 1919, pp. 199–200); reference on pp. 6–14. See also Fernand Van Ortroy: Biobibliographie de Gemma Frisius, fondateur de l'école belge de géographie, de son fils Corneille, et de ses neveux les Arsenius, *Mémoires Acad. Royale de Belgique, Classe des Lettres et des Sci. Morales et Polit.*, Ser. 2, Vol. 11, Fasc. 2, Brussels, 1920 (reviewed in *Geogr. Rev.*, Vol. 13, 1923, pp. 325–326); reference on pp. 145–150.

[24] These have been made the object of a special study by Hermann Wagner in his articles "Gerhard Mercator und die ersten Loxodromen auf Karten," *Annal. der Hydrogr. und Marit. Meteorol.*, Vol. 43, 1915, pp. 299–311 and 343–352, and "Die loxodromische Kurve bei G. Mercator," *Nachr. Gesell. der Wiss. zu Göttingen, Phil.-hist. Klasse*, 1917, pp. 254–267.

1513 and described by Drecker,[25] have upon them a map, which, notwithstanding the small scale, shows with a fair degree of exactness the system of increasing latitudes employed by Mercator in his great map of 1569. Surely, as Drecker observes, the idea of the projection must be still older; it cannot have been invented specifically for the sundial where the map and its projection were matters of merely secondary interest.

Since the gores of Mercator's terrestrial globe first came to light in Ghent in 1868, a number of specimens of both the terrestrial and celestial (1551) globes have been discovered. In Vienna I found, besides the pair in the National Library (formerly the k. k. Hofbibliothek), a second pair in the convent of the Dominicans ("Alte Globen," Nos. 21 and 37).[26]

The Late Sixteenth Century

The late sixteenth century is remarkable for the production of artistic globes. The delicate drawing on De Mongenet's gores (Figs. 63 and 64) may also be admired in a copy of the Italian edition (c. 1560) in the Hauslab-Liechtenstein collection (see "Alte Globen," No. 4). The celestial globe of Georg Roll, of which Stevenson (Vol. 1, p. 181) was unable to get a description, is not in the Hofbibliothek as he asserts. Preserved until 1891 in the Imperial Treasury (k. k. Schatzkammer), it was removed together with other precious works of art to the new Kunsthistorische Museum when the latter was opened. This globe, a very sumptuous piece, was made for the Emperor Rudolf II (1576–1612). Rudolf, though a bad ruler, was much interested in science—or, rather, in astrology and alchemy—and was the patron of Kepler and Tycho Brahe. The globe bears the inscription: *1584 Factum in Agusta* [sic] *per Georgium Roll;* the date 1588 in the Guidebook of the Museum is therefore wrong. The equipment and ornamentation is similar to that of the Dresden globe (Fig. 74) made by Roll and Reinhard at Augsburg in 1586. The material is brass, richly gilded, with the constellations painted in enamel. Clockwork is found inside the celestial globe and also, as it seems, in the small terrestrial globe which forms part of the same piece. The diameter of the inner border of the brass horizon is thirty centimeters, of the celestial sphere about twenty centimeters, and of the terrestrial sphere less than nine centimeters. The top is not an armillary sphere, as on the Dresden globe, but a female figure (Urania) with astronomical attributes.

In the Kunsthistorische Museum there are several other pieces which deserve mention: an armillary sphere supported by a Hercules, in gilded

[25] Jos. Drecker: Ein Instrument, eine Karte und eine Schrift des Nürnberger Kartographen und Kompastmachers Erhard Etzlaub, *Annal. der Hydrogr. und Marit. Meteorol.*, Vol. 45, 1917, pp. 217–224 and Pl. 11; Ernst Hammer: Die Mercator-Projektion und Erhart Etzlaub, *Petermanns Mitt.*, Vol. 63, 1917, pp. 303–304; W. Wolkenhauer: Erhard Etzlaubs Reisekarte durch Deutschland 1501." Berlin, 1919, pp. 12–13.

[26] The "Convent of Adamont, Istria" (Stevenson, Vol. 1, p. 133) should be "The Convent of Admont, Styria." In regard to the remarks on the library of Louvain (Vol. 1, p. 143, note 65) I share the author's apprehension that manuscripts of Mercator may have been destroyed by the fatal fire of 1914. On the other hand, as I am informed, there is no reason for supposing that any objects of the library were carried away except for safekeeping.

brass, the fine work of a Viennese goldsmith of the seventeenth century; a mathematical instrument with a small terrestrial globe in silver gilt, made for the Emperor Ferdinand III (1637–1657); a glass globe by J. Danckerts of Amsterdam, showing, though of course much exaggerated, the oblate form of the earth (circumference on the equator, 59.1 cm.; on a meridian, 57 cm.). A similar flattened globe (diameters 180 and 194 cm.) by Moroncelli (1713) is described by Stevenson (Vol. 2, p. 86). Danckerts' glass ball is covered on the inside with paper upon which the map was drawn with a pen. The approximate date may be inferred from the names "Nieu Amsterdam" and "Ollandia nova" at the positions of the city and state of New York. A more complete list of the globes in the Kunsthistorisches Museum may be found in "Alte Globen," Nos. 8–16.

Particularly interesting among these objects of art is a goblet globe, probably the work of a goldsmith in Augsburg or Nuremberg during the late sixteenth century. It is supported by a figure of Atlas and overtopped by a small armillary sphere, the total height being fifty-five centimeters, and the diameter of the ball eighteen. This pleasing work of art should be taken into consideration in connection with Stevenson's interesting account (Vol. 1, pp. 198 *et sqq.*) of the artistic style of globes peculiar to southern Germany in the second half of the sixteenth century.

We cannot dwell here upon the important globes of Philip Apian, Tycho Brahe, Molyneux, and others but must confine ourselves to a few minor points. Stevenson's interrogation marks for his translations of *pollici* (Vol. 1, p. 156) and of *Schuh* (Vol. 1, p. 158) are unnecessary. *Pollice*, from the Latin *pollex*, like the French *pouce* (properly "thumb"), is a regular Italian word for "inch." *Schuh* is a common synonym for *Fuss*, more frequently used in popular than in written language. The "Dane Skolnus" referred to on the Rouen globe as "Joannes Scovus" (Vol. 1, p. 190), was in reality a Pole from the little town of Kolno near the frontier of East Prussia. From his native town he was called in Polish *z Kolna*, "from Kolno," which was Latinized to *Scolnus*. He is said to have sailed to Greenland in 1476 by order of Christian I of Denmark, but this voyage is somewhat doubtful.[27]

The Dutch and Belgian School of Globe Makers of the Late Sixteenth and Early Seventeenth Centuries

The late sixteenth century was marked by the heroic struggle for independence of the Netherlands with Spain. In close connection with this came a wonderful expansion of Dutch commerce, navigation, science, and art. The climax of this movement, reached about 1650 immediately after the dismemberment of the Netherlands from the Holy Roman Empire, was soon followed by decline during the years of rivalry with England. Cromwell's Navigation Act of 1651 and the naval wars with Britain, 1652–1654 and 1664–1667, were deadly blows aimed against the Dutch claims to

[27] See Kretschmer, *op. cit.*, p. 244; Sophus Ruge: Geschichte des Zeitalters der Entdeckungen, Berlin, 1881, p. 222.

mastery of the sea which had been maintained since the rout of the Spanish Armada in 1588. During the period when Amsterdam was the commercial and financial center of Europe the Netherlands had acquired from the Portuguese inheritance (Portugal was united with Spain from 1580 to 1640) their immense colonial empire in the East Indies, in South Africa, and in both Americas. Bold Dutch seamen had drawn the first outlines of the fifth continent, called "New Holland" until in the nineteenth century the name was replaced by "Australia," reminiscent of the mythical "Terra Australis" of older maps.

It is no wonder that the Dutch period of world commerce gave a mighty impetus to the study of geography. The great tradition of Mercator and Ortelius incited Dutch map makers—Jan Jansson, William and Jan Blaeu, and others—to the compilation of atlases which even to the present day have been excelled by none in size, completeness, and magnificence.[28] A fundamental treatise on general geography by Bernhard Varenius was published in Amsterdam in 1650 and was later re-edited by Sir Isaac Newton. Leyden became the birthplace of historical geography with the publication of the work of Philipp Cluverius, who, like Varenius, had emigrated from Germany. The Netherlands also held a prominent place in the construction of globes. We need merely refer to Stevenson's luminous description of the works of Van Langren, the Hondius and Blaeus, the Valks and others, already partially familiar to us through the author's reproduction of Hondius' Map of the World, 1907, and through his monograph on Willem Janszoon Blaeu, 1914. We may be permitted, however, to make a few additional remarks.

The date, 1592, of the Hondius globe in Nuremberg (Vol. 2, p. 4) of which Stevenson is in doubt, is confirmed by Johannes Müller[29] in a list in which there are also mentioned several globes which seem to have escaped the attention of our author, especially a large set of Blaeu and Doppelmayr (pp. 75–78).

The dedication on the Hondius globe of 1600 (Vol. 2, p. 8), *clarissimis . . . sapientiae . . . officinis Academiae Lugdunensis Batavorum et Francveriensis* is translated "of the Academy of Leiden and of Frankfurt." Now Frankfurt, though always an important commercial town and even a political center in the old German Empire, scarcely played an important part in the intellectual life of Germany before Goethe was born there. The present excellent university at Frankfurt is of quite recent date. The Academy in question is that of Franeker, now a quiet little town in the Dutch province of Friesland, but once the seat of a prosperous university founded in 1585 and dissolved by Napoleon I in 1811. The Latin form of the name is *Franechera*, *Franequera*, or the like. In this connection we may rectify the

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[28] Compare W. Redmond Cross: Dutch Cartographers of the Seventeenth Century, *Geogr. Rev.*, Vol. 6, 1918, pp. 66–70.

[29] See Johannes Müller: Katalog der historisch-geographischen Ausstellung des 16. Deutschen Geographentages zu Nürnberg, Nuremberg, 1907, No. 295.

apparently inexact reading on the celestial globe of Jan Jansson (Vol. 2, p. 67) which seems to have caused the translator some trouble. *Sphaera . . . Adriani Metii Watheseos apud Frunequeranos Professoris . . . observationibus*, etc., means "by the observations of Adrian Metius, professor of mathematics at the University of Franeker."[30]

A pair of Blaeu's globes of 1640 (diameter, 67 cm.) are in the Liechtenstein collection; another in the National Library at Vienna (see "Alte Globen," Nos. 7 and 20). There are also Blaeu's globes of 1599 (diameter, 34 cm.) and Valk's globes of 1707 (diameter, 39 cm.) in the latter institution (*ibid.*, Nos. 22 and 23).

In Figures 140 and 141 Stevenson gives a reproduction of the terrestrial and celestial globe gores by Joannes Oterschaden from the originals in the collection of the Hispanic Society of America. I found the same gores in the Liechtenstein collection ("Alte Globen," No. 5). There is no reference in Stevenson's text, but in any case the date, "ca. 1675" given by him for the gores is untenable. The fact that the character and writing would seem to show that they must be older is confirmed by the dedication to *Vrbano Sangelasio Episcopo Commingiensi*, whose coat of arms is seen on the celestial globe. Comminges, the name of which is derived from the Gallic tribe of Convenae, is a district in Gascony once a bishopric and now in the *département* of Haute Garonne. The reign of Urban de St. Gelais extended from 1570 to 1613.[31] By inadvertence the second gore in the lower part of the terrestrial globe is turned upside down in both the New York and the Vienna copies so that the western part of North America comes into the southern hemisphere. Nothing further is known about the author, Oterschaden, a Belgian.[32]

Globe Making in Eastern Asia

A word must be said on globe making in Eastern Asia. Stevenson (Vol. 2, pp. 128 *et sqq.*) gives a good description, with illustrations, of the much

[30] At this point some other slight mistakes in the translation of Latin texts may be corrected. The inscription on the Plancius globe (Vol. 2, pp. 47 *et seq.*), *Naucleros docuit volubiles libellas magnetis virtute infectas*, can scarcely be rendered by "loose leaves . . . under the electrical influence." *Libella* (diminutive of *libra*, not from *liber*) means usually "water level" but here, obviously, the magnetic needle. The title of Valk's globe (Vol. 2, p. 148), *Cosmotheore* (i. e. "representation of the world"), is misprinted *Cosmotherium* in Stevenson's translation. *Matth. Seutteri Calcogr: August.* means, of course, "Mattheus Seutter, engraver in Augsburg," not "renowned engraver" (Vol. 2, p. 155).

[31] Gallia christiana, Paris, 1870, Vol. 1, col. 1108.

Conrad Eubel: Hierarchia catholica medii aevi, Regensburg, 1910–14, Vol. 3, p. 193.

[32] Among the gigantic globes of the late seventeenth century there are in Vienna three pairs by Coronelli (diameter, 110 cm.), two in the National Library, and one in the University Library ("Alte Globen," Nos. 18, 19, and 28). A Moroncelli celestial globe of 1713 (diameter, 50 cm.) is in private possession in Vienna (*ibid.*, No. 39). On other globes of the eighteenth and early nineteenth centuries, especially the monumental architectonic globes on the buildings of the National Library and of the Bundesvermessungsamt (formerly k. u. k. militärgeographisches Institut) see the same list, Nos. 26 and 36. Particularly interesting is a pair of copper globes (diameter, 31 cm.) with very complete armature, which I found in the Library of the "Schottenstift," or convent of the (originally) Scotch Congregation of the Benedictine monks (*ibid.*, No. 38). The engraving, particularly of the constellations, is of remarkable elegance and beauty. The celestial globe is signed *Authore Leonardo Reisch Algojo. Anno 1701. Algojo* means "from Algäu" (or Allgäu), the valley of the Iller in the Bavarian Alps between the Lake of Constance and the River Lech, well known for its cattle breeding. The author seems to be identical with the maker of an orrery mentioned in Jöcher's "Allgemeine Gelehrtenlexicon," Supplement VI, pp. 1740 *et seq.*

discussed instruments in Peking dating from the Mongol and Jesuit periods. The Mongol instruments are exclusively astronomical: they cannot be regarded otherwise, since nobody in China at the time knew the spherical form of the earth. Among the instruments of the Jesuit Verbiest we find several armillary spheres and a celestial, but no terrestrial, globe. After the Boxer rebellion a very fine specimen of a terrestrial globe, however, was found in a curiosity shop in Peking by Mr. A. Rosthorn, former Austro-Hungarian minister in Peking and Teheran. It probably came from the Imperial palace and is now deposited in the Hofburg in Vienna (see "Alte Globen," No. 45). The ball is of silver, has a diameter of 22 centimeters, and revolves in two directions around a vertical and around a horizontal axis. The pedestal is of carved wood of typical Chinese workmanship. The globe is covered with numerous Chinese legends and with a graduation of ten degrees. Continents and islands are shown in colored enamel. The drawing indicates that the globe was made after the journey of Abel Tasman, but before Cook's voyages, that is between 1650 and 1770. The references to the literature on Chinese globes and instruments can be completed from Cordier's "Bibliotheca Sinica"[33] and from the works of Matteo Ricci, the founder of the Jesuit mission in China, 1582–1610. After the recovery of the original manuscripts a monumental edition of Ricci's works was prepared in his birthplace, Macerata.[34] Here we read in his "Commentarj" (pp. 23 and 315 *et seq.*), a description of astronomical instruments of the Mongol period in Nanking, similar but somewhat superior to those of Peking. There is, of course, no trace of a terrestrial globe. A high mandarin, Lingozuon, however, was much interested in map making, and, having been instructed by Ricci in Western science, made, as Ricci tells us (p. 396), a terrestrial and a celestial globe, "assai belli." This is the only example from China, besides the Vienna specimen, of which I have positive knowledge.

Another work of the same period from Japan has been made known to us. Stevenson strangely seems to have overlooked a notice in S. Günther's "Erd- und Himmelsgloben" (p. 85, note 3) of a paper by O. Heeren[35] (mentioned, however, in the Bibliography). The globe there described and reproduced in an insufficient photograph is not mounted but is printed in four gores each of which corresponds to ninety degrees of longitude. It is doubtful whether it would be possible to mount them satisfactorily on a ball. Several copies are known: I saw one in the Museum für Völkerkunde in Leipzig and have been informed that there is another in Hamburg. The drawing shows no relation to the Chinese globe in Vienna and probably

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[33] Henri Cordier: Bibliotheca Sinica: Dictionnaire bibliographique des ouvrages relatifs à l'empire chinois, 4 vols., Paris, 1904–08; reference in Vol. 2, cols. 1440 *et sqq.* I am informed that a supplement of this fundamental work is at present in press.

[34] Opere storiche del P. Matteo Ricci, S. I., edite a cura del comitato per le onoranze nazionali, con prolegomeni, note e tavole, dal P. Pietro Tacchi Venturi, S. I.: Vol. 1, I commentarj della Cina; Vol. 2, Le lettere dalla Cina (1580–1610). Marcerata, 1911–13.

[35] O. Heeren: Eine japanische Erdkugel, *Mitt. Deutsch. Gesell. für Natur- und Völkerkunde Ostasiens* [in Tokyo], Vol. 1, 1873–76, No. 2, pp. 9–13.

reveals Dutch influence, as the Dutch alone at the period maintained commercial relations with Japan albeit on a very limited scale. The numerous legends, which are translated by Heeren, end with the date corresponding to A. D. 1670 and give the name of the author as Tasu-i-san-tetsu. The name is preceded by the following noteworthy legend: "My fatherland is a fine country, for people of other countries come hither and tell the condition of those lands. On the basis of such reports and of the books 'San-Sai-su-e' and 'To-shio-hen,' which I have read and thought over, I have constructed this globe whereon all countries are shown. 'Until now the earth was considered as flat, why didst thou make her round?' they asked me. I answered: 'In "To-shio-hen" it is written, the earth is round like a ball, therefore I made and pictured her thus.'"

GEOGRAPHIC PROVINCES OF ANGOLA

AN OUTLINE BASED ON RECENT SOURCES*

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Note on the Sources

No part of Africa has been so neglected by writers in English as Angola. This is natural, since the colony always has been Portuguese except for a short period of Dutch rule and since the inhabited sections are separated from British holdings by great stretches of unknown and difficult "hunger country." Thus Colonel Statham's venture into this field with "Through Angola, a Coming Colony" is a novelty. Interested in hunting big game, the greater part of his book covers personal experiences in his pursuit of the antelope; as regards geographic and economic problems it is chiefly useful for what can be read between the lines. Some of the illustrations depict geographical conditions excellently.

Two recent expeditions, headed by Count Rohan-Chabot and Professor Taruffi respectively, had scientific objectives—the former general exploration, the latter a study of agricultural possibilities with a view to Italian immigration. Each expedition confined itself to a single section of the colony and made careful observations. Those of the French mission are objective in tone; the Italian expedition has been written up somewhat in the vein of propaganda for settlers.

Marquardsen's monograph on Angola is also based on personal observation in part. But in addition it incorporates all the information available in literature at the time of publication and is an all-round serious geographic study. It bears evidence of the painstaking care and thoroughness with which German scientists generally are accredited and likewise evidence of the complementary undiscriminating acceptance of sources at their face value. In spite of faults, however, this is by all odds the best study of Angola in any language. There is a large-scale map (1:2,000,000) for relief, drainage, places, transportation, and political subdivisions, in addition to useful sketch maps.

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* J. C. B. Statham: Through Angola, a Coming Colony. xvi and 388 pp.; maps, ills., bibliogr., index. William Blackwood and Sons, Edinburgh and London, 1922.

Jacques de Rohan-Chabot: Notes sur l'Angola (Mission Rohan-Chabot). Ills. *La Géographie*, Vol. 35, 1921, pp. 1–16.

G. Grimaud: Principaux résultats scientifiques obtenus par la mission (Mission Rohan-Chabot). *Ibid.*, pp. 17–26.

Dino Taruffi: L'Altipiano di Benguella (Angola) ed il suo avvenire agricolo. 48 pp.; maps, ills. *Relazioni e monografie agrario-coloniali No. 8.* Ist. Agric. Coloniale Italiano, Florence, 1916.

Hugo Marquardsen: Angola. viii and 134 pp.; maps, diagrs., ills., index. Dietrich Reimer (Ernst Vohsen), Berlin, 1920.

The Country As a Whole

Most of the interior of Angola is inaccurately mapped, and there are whole districts scattered throughout the Colony which are almost unknown to the outside world. In fact, exact information about any part of Angola is confined to the few routes of communication white men can use. The general conditions noted in these narrow strips may, however, be inferred to exist for a varying distance to either side.

Relief

Relief dominates life conditions throughout the region (Fig. 1). A lowland varying in width from 20 to 200 kilometers (12 to 120 miles) borders the sea. This is backed by abruptly rising crystalline mountain ranges which mark the western edge of the extensive plateau of South Africa. From these ancient mountains in latitude about 13° S. a watershed of younger rocks projects irregularly eastward, like a long low-pitched roof. The area in which the north-south-trending crystalline ridge intersects the east-west-trending watershed is the highest land in Angola—the plateau of Benguella, peaks of which rise to 2600 meters (8000 feet). To north and to south lie rugged plateaus of somewhat lower elevation, separated from each other by valleys of streams flowing to the Atlantic which have cut through them and the crystalline rampart. Eastward the mountainous plateaus give way to hill or rolling country, which in turn descends to the flat or gently undulating expanses where affluents of the Zambezi and the Congo take their rise.

Climate

Along the coast the mean temperature is low for the latitude because of the cool ocean current, and on the higher plateaus because of elevation; in the lower interior plateaus continental influences result in greater annual range than either in the highlands or on the coast. Among observed stations there is a variation during the year of 3° C. at Malange, on the highland back of Loanda, and of 12° C. at Kuringkuru, on the margin of the Kalahari Desert—the stations showing respectively least and greatest mean annual ranges. Daily range on the highland is greater than annual range, amounting to 30° C. in some places during the dry season. The mean temperature tends to increase from the coast inland, although the high relief gives rise to abrupt changes instead of gradual transition. Along the coast there is a gradual increase from south to north. In the interior, contrary to expectation, temperature increases from north to south, apparently because of winds from the heated lands to the southeast. No frost data are available, although the mean minimum temperatures indicate that it may occur on the highlands in the dry season. Travelers corroborate this evidence by asserting that frost appears every winter in the plateau of the south. The lowest temperature ever reported is—4.8° C. (on the Huilla plateau).

The rainy season lasts generally from October to May, although in the

moister sections (the plateaus of Loanda and Benguella and the Congo drainage basin) the rains may begin in September. In most places there is a marked let-up of rain at about the turn of the year; the maximum which follows generally is more pronounced than that which precedes. The amount of the annual rainfall varies widely, but since it is nowhere great, considering the high temperature and consequent rapid evaporation, drought is the condition to be feared rather than floods. Nevertheless, the rain sometimes falls in unpleasantly large quantities, particularly on the highlands and the interior plains, where thunderstorms are much more common than along the coast. Over most of the plateau the mean annual rainfall is between 1000 and 1500 millimeters, with a decrease towards the south. Decrease from north to south along the coastal strip is illustrated by Loanda, 296 millimeters, and Mossamedes, 22 millimeters.

Relative humidity varies greatly from place to place. Along the coast and in the Congo basin it is high the year round (from 70 to 86 per cent). In the highlands of Loanda and Benguella the average for the year is about the same, but the range lies between 65 per cent in the dry months and 88 per cent in the period of rains. In the highlands back of Mossamedes the air is much drier, relative humidity ranging from 32 to 66 per cent. A special peculiarity of the Angolan climate is the fog which, throughout the dry season, rises about 9 A. M. and swathes the whole region. So characteristic is this fog that its name, "cacimbo," is used by the settlers to denote the dry season.

The coastal zone is fanned by an almost steady sea breeze. Inland the winds are more variable. In the wet season easterly winds bring a considerable part of the rainfall to the interior. In the dry season air moves out from the interior of the continent, and in most of inland Angola easterly winds are more frequent than any others. At all seasons such westerly winds as blow move from cool ocean to hot land and therefore tend to be dry.

Hydrography

Reference has already been made to the east-west-trending watershed, one of the main divides of the continent, whence streams make their way in all directions. The streams fluctuate greatly in volume because of the seasonal character of the rainfall. In the drought the smaller streams all along the coast, and all those south of Benguella, lose themselves in their sandy beds. Some of the waters flowing from the watershed to south and to north join forces to cut their way by rapids through the crystalline front of the continental escarpment and so to the Atlantic. The rest, after a tumultuous start among the rugged highlands, meander sluggishly through wide marshy valleys across the interior plain and finally combine into three systems—the Congo to the northeast, the Zambezi to the east, and the basin drainage of the Etosha Salt Pan to the southeast. During the rains all the Angolan feeders to these three drainage systems flood their shallow

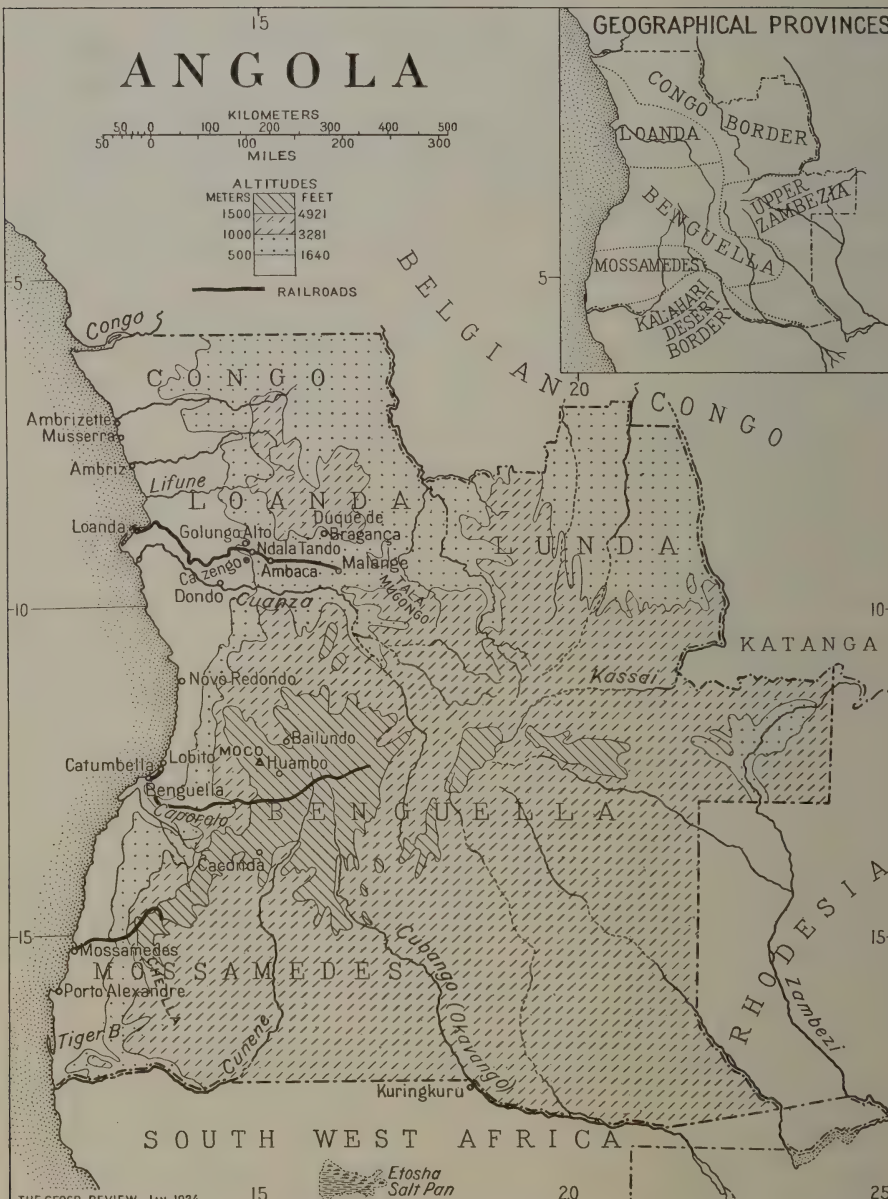

FIG. 1—Relief map of Angola (scale 1:13,000,000) with inset showing geographical provinces.

valleys for miles on either side of the channel; with the drought they gradually shrink, leaving lagoons and marshes as outliers.

The several natural resources of the region are so varied and so dependent on the differences in relief and in climate that they can be best considered province by province.[1]

[1] That is geographical province: the suggested division is derived from a study of the works under discussion but is not outlined by any of them.

Geographical Provinces

The political boundaries of the Portuguese colony of Angola fall within zones of geographical transition. Consequently, while they do not mark exact limits of a geographic region, they do coincide roughly with the outlines of a distinct unit which might be named the Angolan Region (Fig. 1). About the periphery of this unified area are three provinces which overlap the political boundary but which, because of transitional environment and sparse population (in the case of the second and third), serve excellently as natural boundaries. These are the Congo Border Province, Upper Zambezia, and the Kalahari Desert Margin. The Angolan Region thus circumscribed comprises, in addition to the three marginal zones, three nuclear provinces—the coast and hinterland of Loanda to the north, the coast and hinterland of Mossamedes to the south, and the coast and hinterland of Benguella in the center. Each of these is separated from its neighbor by a zone of meager resources and sparse population and communicates with the others chiefly by way of the coasting route.

Benguella

The core of the region is the province of Benguella. Its coastal plain is more healthful than that of Loanda and richer than that of Mossamedes; its highland embraces more than 45,000 of the 78,000 square kilometers estimated to be fit for settlement by Europeans in the colony as a whole, and the actively projected railroad into Katanga traverses the heart of the province.

The Coast Land of Benguella

The coastal belt of the province of Benguella is narrow even for South Africa, being only 20 kilometers wide back of Catumbella. Although the land rises in a series of low terraces, semi-aridity and porous soil confine the population to the irrigable valleys of the streams. North of Novo Redondo to the Cuanza mouth the stretch of sandy waste is wider, streams are few and small, and the country is almost unknown. South of the Caporolo River the numerous streams are deeply incised into the high, steep coastal front, leaving no room for irrigation. This section of the coast is accounted the most worthless in Angola. Both these barren stretches are devoid of harbors. The combination of repellent conditions isolates the intervening string of settlements from other coastal towns.

Benguella, on an exposed harbor at the mouth of a little stream, is the ancient economic and political metropolis of the province. Like most of the coast towns it is cooled by the sea breezes, and its rainfall is slight enough to favor European occupation. The town is built of stone, with balconied houses set along wide avenues, each residence in its own high-walled slave compound. The population is fed by gardens in the valley of the stream back of the villages. In spite of these favoring conditions the place is reputed very unhealthful, probably because of the collection of filth in the stagnant

waters of the river. The slight efforts at sanitation already made have improved matters, and there is every reason to suppose that further sanitary measures would render the place as healthful as any along that stretch of coast. While it still retains its position as administrative center, Benguella has lost its commercial activities to Lobito. Lobito Bay, like all the other good harbors along this coast, is formed by a spit of sand laid down by the northward-flowing ocean current, which picks up its material from the flooded stream mouths. Since there are almost no winds from the northeast, the protection afforded by the low tongue of land is perfect. In spite of the excellence of the harbor, Lobito Bay was unused until the railroad was constructed. Even now power, light, food, and water must be brought eight miles from the Catumbella River. The railroad was begun in 1903, and thus far the village is confined to the sand spit, the natural site for wharves and warehouses. It is breezy and free from mosquitoes; but space is limited, and it is supposed that residences finally will be erected on the mainland, which rises abruptly as a low, hilly ridge of yellow limestone.

The whole coastal zone is underlain by limestone, marl, and sandstone of Cretaceous age, reaching an elevation of 100 meters along its inner margin. It bears some scrub but so sparsely as to appear bare from the sea except along stream lines, which support a luxuriant flora including palms.

The Benguella Upland

Behind the narrow coastal plain rises the crystalline zone in a series of mighty steps, in all more than 200 kilometers wide. The valleys are cut deeply into the face of the lower escarpment and are concealed by dense tropical vegetation. The gorge traversed by the Benguella Railway has a gradient of 700 feet in six miles, a part of which the railroad climbs by use of rack and pinion. The terrace to which access is thus gained is desolate, with outcropping boulders and granite domes. The vegetation consists of a sprinkling of dust-covered baobabs, acacias, and agaves. The higher terraces are progressively moister; scrub gives way to mixed park and grassland, which support animal and bird life; and there are some experimental farms. The upper terraces are so wide as to give the impression of plateau, but the crest of the crystallines lies behind them in a series of ranges chiefly of granite and quartzite. Moco, in the Elongo Range, is 2620 meters above sea level and is the highest point in Angola; many other peaks exceed 2000 meters. But the general level on either side of the crest ranges lies at 1200 to 1700 meters.

East of the high ranges extends the true plateau. This is the center of population for the whole province, both native and European. Between the crest ranges and the Cuanza River it is hilly; and on slopes occur rocky outcrops, chiefly crystalline. The better soils lie on the sedimentaries which cover the crystallines over most of the area. Both in this section and on the terraces west of the crest line the soil is poor in lime and nitrogen but rich

in potash. The higher mountain groups support a moderately dense stand of trees, almost unbroken on the west slopes. The less rugged land is likely to be carpeted with coarse grasses interspersed with occasional patches of scrub, particularly in sheltered valleys. Such trees as exist rarely overtop fifteen meters, and they cast but a slight shadow with their thin leaves. The trunks are so crooked and branches are so numerous that they make poor lumber. There is no underbrush, and the vegetation nowhere forms a formidable barrier to communication. The chief obstacles to movement are the countless streams which take source in the highland. During the rainy season they form impassable torrents, and in the drought only the smallest dry up, while the others retract to the lowest part of their wide flood plains, leaving muddy lagoons and treacherous marshes. There is not a paved road on the plateau, and few bridges have been built.

The climate of the plateau is wholly suitable to Europeans, at least in the districts centering on Bailundo, Huambo, and Caconda. Nevertheless, it does not appear to be as salubrious as has commonly been believed. Fever occurs everywhere; although, except for black-water fever, it is rarely fatal. Europeans generally suffer with rheumatism, but this may be due to wretched living conditions. In the dry season there is a daily range of temperature amounting to 30° C. at the maximum, which occasions a good deal of throat and lung disaffection. The tsetse fly, however, is absent; hence sleeping sickness is unknown.

In the several districts on the highland trade is the all-engrossing occupation, engaged in by nearly all the whites and by two-thirds of the native men. Rubber from the district east of the Cuchi River has been the principal item in the trade. Most of the Europeans are Portuguese. Their houses may be of adobe but are more usually of mud-plastered poles with a thatch or iron roof. The settlers feel themselves to be economic exiles and work only to accumulate enough funds to return to the mother country. They neglect the agricultural possibilities in legumes, cereals (other than wheat), tobacco, and European vegetables and fruits. Nearly all have patches of wheat and yams. The wheat, planted in February, is their staple food; the yams are converted into spirits. Until the trade was prohibited by law in 1911 liquor was a principal medium of exchange in dealings with the natives. Indications point to illicit but persistent use since that date. The natives plant a little maize, sorghum, beans, manioc, yams, and tobacco; but they disdain irrigation, and poor methods of cultivation combined with the erratic rainfall often result in partial crop failure. After two or three years' cultivation a field is abandoned as exhausted. The only serious experiments in agriculture are those of the mission stations and of companies chartered for exploiting the country. Experiments thus far made indicate that holdings should comprise at least 12,000 acres, that the heavy work should be performed by tractors, and that tuberous crops should be the mainstay—with some cereals, which generally are less dependable. Lack of labor is a grave problem, as it is for Angola as a whole. Whilst

abuses exist of course, the native is now well taken care of by the law, the ordinances of 1921 permitting no compulsory labor for agricultural or other work except in the case of public works under special conditions.

Animal husbandry has been practiced scarcely at all by whites and little by natives. Previous to an epidemic of rinderpest some decades ago native cattle were not uncommon; but now it is hard to buy an ox, and the price is two or three times the old figure. Even the districts which were spared, as Bailundo, neglected their cattle business for the rubber trade. Imported cattle do not survive lung disease unless inoculated. Horses and mules from Europe are rapidly taken off, but Cape breeds do better. For his own use every native keeps poultry and perhaps goats, sheep, or hogs. Yet there are possibilities for a ranching industry on the plateau, and live stock are in demand in the Katanga mining region.[2]

Except for the demand for cattle in southern Katanga there is no outside market for farm produce because of high cost of transportation. Only those commodities which are valuable and compact can be marketed profitably at Benguella or Lobito. Of these, rubber from the interior is the chief, and for it the highlanders are middlemen. Wax, salt, pearls, and cloth are minor articles of commerce. The media of exchange are spirits, weapons, munitions, beads, and in dry years provisions. Occasional local traders join caravans *en route* to eastern Angola and the Belgian Congo, where they get rubber and contract labor for the plantations of São Thomé. Conditions under which this contract labor system operated were long unsatisfactory but have been ameliorated in late years.[3]

Loanda

The province of Loanda, comprising the long stretch of populated coast between the Congo and Cuanza Rivers and the highlands on either side of the latter stream's lower course, is older, better known, and further developed than the Benguella province. Nevertheless, the coast land is warmer and moister and the highland is lower and smaller than are those of Benguella. The area of plateau fit for European occupation includes some 21,000 square kilometers, but probably most of it is unsuited to permanent settlement.

The Loanda Coast Land

As elsewhere along the Angolan coast, a strip of sedimentary material laps over the crystalline core of the continent. In this province limestone predominates, varying from brick red in the north to yellow and white farther south. Here and there rise hills of granite, locally called "pillars," which serve as guides for mariners. Those at Ambriz, Musserra, and north of the Lifune River are the most notable. The coast rises abruptly to

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[2] A. B. Hutcheon: Report on the Economic Conditions in Angola (Portuguese West Africa), Dept. of Overseas Trade, London, 1923, p. 10.

[3] See "San Thomé and Principe," *Handbooks Prepared Under the Direction of the Historical Section of the Foreign Office, No. 119*, London, 1920.

twenty or thirty meters, then stretches for a breadth of 100 to 150 kilometers as a strongly undulating plain. Toward the landward margin the relief takes the form of parallel ridges of limestone, sandstone, and conglomerate. For the most part this is desolate country. Near the Congo there is park land, but both grass and trees thin out to the southward. The raffia palm does not grow south of Ambrizette; the cashew extends to the Cuanza River. Baobab is the commonest of the trees along this whole section of coast and occurs in clumps, at least in the north. In the southern section acacias, euphorbias, and agaves replace the moisture-loving plants. The strip adjacent to the highland has somewhat denser vegetation. Flood plains of streams form oases of brilliant green in this waste of yellow and drab. Here sugar cane is grown, and little distilleries dot the streams. The port towns are fed by near-by oases. For example, the Bengo, 30 kilometers from Loanda, furnishes that city with vegetables and fruits and even with hay for the draft animals. Timber for construction and nut-bearing trees grow in these stream valleys. On the islands before Loanda the coco palm thrives. In the last few years the world-wide search for petroleum has included Angola, and various points along the plateau foreland are being prospected.

The Cuanza River is responsible for a combination of conditions which favor commerce. This stream, the largest in the Colony (exclusive of the Congo), is master of a great watershed comprising much of the rainy highland. A thousand miles from its mouth it is 100 meters across in the dry season. Navigability is interrupted in the middle course by a series of falls which make this district one of the most picturesque in Africa. From Dondo the river is again navigable to the sea, a distance of 200 kilometers. Apart from the Congo, this is the only stream of Angola that directly opens up a part of the interior, for from Dondo the highlands on both sides of the river can be reached by trail. Livingstone reported that in 1854 ten or twelve great rowboats passed daily. In 1866 steam navigation was introduced, and by the early seventies the trade in palm oil and nuts, coffee, groundnuts, and other products was flourishing. Dondo, head of navigation, still remains a center of some importance, although it is sheltered from the breeze and is fever-stricken, and the railroad has diverted part of its business.

Loanda, the port for the Cuanza trade, profited greatly from its position near the mouth of the stream. The town, pitched on the protected harbor formed by detritus brought down by the annual floods of the Cuanza, was the first important European settlement in Angola. Loanda is divided into a lower, or commercial, town, which consists of a strand on which are built shops and houses, hotels, theater, and railroad station; and an upper town where are the government offices, residences, and on the highest crag the ancient fort. The temperature is rather low for the latitude and the town is exposed to the fresh sea breezes which blow with considerable velocity all year round. Precipitation is not great, and thunderstorms are rare. Native limestone is used for buildings, many of which are very ancient.

Lime for the mortar is made from mussel shells. The irrigated plantations of the Bengo furnish the food, the stream itself supplies the water, and salt is evaporated from sea water at Cacoaco. Loanda is the seat of administration for the Colony, a dignity descended from the days when it was the chief commercial center as well. Although there are trails to the interior from the settlements of Ambrizette and Ambriz and although the Cuanza River still is used to reach the small upland settlements south of that stream, the wood-burning Loanda Railway is now the chief route to the highland.

The Loanda Upland

As elsewhere in the Colony the western border of the highland is of crystalline structure, in this section chiefly of gneiss, granite, and slaty quartzite. In the hills of Cazengo and Golungo Alto the average elevation is a little more than 500 meters, although individual peaks rise higher. Farther inland the rise continues stepwise to about 700 meters in the vicinity of Ndala Tando. In this district sandstones, conglomerates, and shales overlie the crystallines in places and give rise to more open and less rugged country. There are some out-crops of crystallines as far inland as Duque de Bragança. East of the 16th meridian sandstones predominate, and the plateau culminates in the Tala Mugongo, a plateau at about the 1000-meter level. It rises so sharply from the west as to simulate mountains. Because of the rise to the continental plateau by rather low steps and the moderate elevation of even the higher levels, the Loanda upland is more accessible than others in Angola.

The inner margin of the coastal zone and the outer margin of the crystalline band, perhaps 100 kilometers in total width, bear plants transitional from dry scrub to magnificent tropical forest which clothes the west flank of the highland over a strip 60 kilometers wide. Among the products of the forest are palm nuts and oil, native coffee, kapok, gums, monkey bread, and wax (from hollow trees). All these grow wild. In addition there are coffee plantations half a century old, sugar cane along the streams, and, by way of novelties, rubber and cacao. The latter is irrigated in the dry season, and the nocturnal fogs are relied upon to provide additional moisture. This Cazengo district is the best developed in the Colony.

The inner highland is covered in places with savana and elsewhere with xerophytic scrub. Along the western margin the grassland is broken with only an occasional baobab. Farther east (about Malange) scrub predominates. The rolling plain is cut with streamlets which rarely fail entirely, and all the requisites of good cattle country seem to be present. Absence of animals is said to be due to rinderpest; but the sparsity of the population is less easy to explain.

All the way from Loanda along the railroad line are traces of abandoned native villages, whose inhabitants have gone to the interior. Some say that these people have fled sleeping sickness, others aver that they have

followed the retreating trade in extractive commodities. On the highland there are manifest signs of decay. Ndala Tando, the largest center, has more than a hundred houses, but several are vacant. Ambaca, earlier a flourishing village, consists now only of the government station and houses for the officials. It has an evil reputation for fever, and this may have decimated the population. Malange, present terminus of the railroad, is typical of the inland towns of recent origin. The station and the official offices, residences, and barracks face each other across a little square from which runs a street of shops and stores, flanked by a cluster of huts. Close beyond lies the jungle. Just what development is expected in the highland does not appear. Gold has been found 75 kilometers north of Ambaca. Iron works have succumbed to competition of imported iron goods. Probably the district around Malange is too low to permit permanent European settlements.

It is possible to cross the less elevated country along the Cuanza and so to reach the Benguella highland; but this is rarely done, as the population is very sparse and the country almost unknown. All of the Cuanza area has been ravaged by sleeping sickness, which first broke out in 1870 and only recently has abated. But this district south of the river probably never was so densely settled as the highlands to north and to south. It is distinctly less favorable to human occupation on account of climate and vegetation. Probably wild animal life is more plentiful and varied than elsewhere in Angola, a fact which sparse population would go far toward explaining.

Mossamedes

Whereas northern Angola was opened to European settlement in the sixteenth century and central Angola in the seventeenth, the southern province received its first permanent white population in the nineteenth. The geographical province of Mossamedes comprises the coast south of the 15th parallel and the highlands behind. Of the upland, only some 12,000 square kilometers are thought to be fit for permanent white occupation.

The Mossamedes Coast Land

The coastal zone is sharply set off from the Benguella coast by steeply rising cliffs of basalt and by an utterly desolate hinterland. Near Mossamedes the flat coast reappears with its limestones, sandstones, and conglomerates of Cretaceous and Tertiary age. But the bed rock stands out only here and there through the sand dunes. Twenty to fifty kilometers from the coast gneiss outcrops appear, first as individual mesas a few meters high, farther inland as hills standing 200–300 meters above the gently ascending sand plain. The foothills of the plateau lie 150–200 kilometers from the sea. The coastal district is reputed a health resort and alone of lowland sections of Angola is indubitably fit for European settlement. Nevertheless, environmental conditions combine to retard its development.

The plateau rises sharply, giving the appearance from below of a towering mountain wall with occasional bastions. Hence access to the interior is more difficult than in the provinces to the north. The coast land is a desert where two years may elapse between rains. Flowers and grasses spring up briefly after the rare showers, but only along the inner margin of the plain is there permanent vegetation—a few little shrubs. There are no natural oases. The Cunene is the only permanent stream between Benguella and the Orange River, but a bar with heavy breakers across its mouth and falls a few kilometers upstream render it useless for navigation. Approach to the coast from the sea is less favorable than in the more northerly sections. Tiger Bay, related to the Cunene as are Lobito to the Catumbella and Loanda to the Cuanza, is wide of mouth and so large that the north part is like a sea. Furthermore, its hinterland is worthless for trade. There are two roadsteads which offer some protection—Porto Alexandre and Mossamedes, and each is near a stream which is being utilized for irrigation. These harbors are no better than that of Benguella, but Mossamedes is the recognized port of the province and has been made the terminus of a railroad. Agriculture is restricted to the lower courses of two streams near Mossamedes and the Coroca farther south. Besides supplying the few white settlements with food, the plantations of these irrigated districts grow sugar and cotton.

The cool ocean off this shore abounds in food fish which are caught in considerable numbers, dried, and sent to São Thomé and to the Congo Basin. In recent years Norwegian whalers have frequented the coast.

The Mossamedes Upland

The true highland of Mossamedes is separated from the Benguella upland by a great knot of crystalline mountains from which radiate four ranges. The two which reach southward are prolonged by the continuous Chella on the west and by several groups of peaks on the east. This little district between 13° 30′ E. and 14° E. is the highland. The Chella rises to a mean elevation of 800 meters above the coastal zone and 50 meters above the interior plateau. It is unbroached in its northern half except by small gorges; to the south it is somewhat lower, but even the Cunene has cut through it only an impassable gorge.[4] At its base the seasonal streams create marshes, and fever abounds. The foothills are covered with bunch grass, bushes, and a few baobabs. The higher slopes, in a strip some 20 kilometers wide, are densely forested with acacias, mopane, baobab, and mimosa. Close undergrowth makes passage difficult except along trails. The toy railroad which crosses the desert from Mossamedes is surveyed to swing round the north end of the range in ascending to the plateau, but this most difficult section has not been constructed.

The whole of the small plateau is rocky with outcrops of granite, schist,

[4] Compare F. E. Kanthack: Notes on the Kunene River, Southern Angola, *Geogr. Journ.*, Vol. 57, 1921, pp. 321–336.

and mica schist, but thus far agriculture is limited by the market rather than by unfavorable environment. The two seasons, general in Angola, are especially well marked in this part. The rains begin with occasional showers in October, increasing to daily storms during November, but subsiding somewhat in December. Commencing in January is the period of "great rains," with a maximum in February and March, after which the showers abate until the end of April, when they cease. Southwest winds are associated with the rain. From May to July there is a diurnal range of 20–30° C., reaching 0° C. or lower at night. Planting is done at the end of the great rains, the crops growing during the less warm season. Wheat, tobacco, and yams do well. Coffee and maize thrive in the lower sections. Cane is grown, but both frost and drought are hazards. In 1903 coffee, cane, bananas, and guava were frozen, although European fruits did not suffer. Before the outbreak of the rinderpest the natives had many cattle and lived largely on meat and milk; since the destruction of their mainstay more attention has been paid to tillage. Europeans have likewise suffered in this respect, the country as a whole languishing with the decline in the cattle trade.

The white population of the highland is made up of mainland Portuguese, Madeira Portuguese, and Boers. Altogether there are only a few hundred, of which 100 families are Boers. The chief business of the Boers is hunting, and they have nearly destroyed the wild animal life which within fifty years abounded in all the less settled districts, not only of the highland proper, but also of the great plain to the eastward. Since the streams are not navigable, goods must be hauled overland, and this work also the Boers do, using their heavy wagons. In their chief settlement their dwellings, half an hour apart, are built in the Transvaal style of architecture. The other villages, settled by Portuguese or by both Portuguese and Boers, vary greatly in size and pretentions.

The Peripheral Provinces

The Desert Margin

In the extreme south and southeast of the Colony desert prevails. Similar conditions continue beyond the political boundary. Between the Cunene and the Cubango (Okavango) the land is a sand flat, underlain by recent sandstones and limestones. In this section the rainfall is small. The streams lose themselves in their permeable beds during the dry season. From January to May the whole country is flooded at irregular intervals, receiving water not only from the Etosha drainage basin but also from the Cubango and the Cunene, which empty a part of their surplus into the thirsty sink. The plain is covered with thorn which is almost impenetrable in places. Fan palm is a characteristic feature of the landscape. A very scanty population ekes out a wretched living.

Upper Zambezia

The country watered by the eastern tributaries of the Zambezi is little known. Like the districts of the middle Cunene (Humbe and Cassinga) it is flat and sandy with sluggish streams meandering through wide marshy valleys. Their tributaries merge during the rains, and the larger streams become incredibly wide at that season. For example the Cuando at its confluence with the Cubia (16° S.) is six to eight kilometers in width. But for 750 kilometers it has a gradient of only half a millimeter in the meter. Streams not more than 10 meters wide are spanned in places with rude native bridges; others are crossed by boats or fords. The population depends upon cattle and is nomadic.

The Congo Border

Extreme northeastern Angola lies in the drainage of the Kassai, one of the major tributaries of the Congo, and belongs properly to the geographical region of the Congo. The parallel valleys set in close rank indicate greater rainfall than occurs elsewhere in the Colony, and those which are not stony or marshy are filled with a thick forest of tall trees and lianas. The inter-stream spaces are covered with savana, steppe, or very dry scrub. Discovery of the diamond fields of Lunda, adjacent to the Kassai fields of the Belgian Congo, has stimulated interest in this section.[5]

The plateau in the north of the Colony is a part of the highland through which the Congo takes its final plunge to the sea. The eastern three-quarters of it is a plateau based on sandstone, shale, and limestone, which reaches its maximum elevation at about 1000 meters in Zombo. The whole upland is deeply dissected, and dense forest fills the valleys, while the upland is grass-covered. From the sedimentary highland, descent to the coast is made over a series of crystalline steps, but this section is almost unknown because the streams are not navigable and the slopes are heavily forested.

Although early occupied, this district has not prospered. It has been called the stepchild of the Portuguese Empire. Supposed to be rich in minerals, it has profited little from them: the copper cannot be marketed, the gold is brought out by natives who refuse to divulge its source, and petroleum has been sought only recently. The natives keep numerous small animals and poultry, but cattle are precluded by the tsetse. The climate forbids the establishment of permanent European settlements. The outlet of the district lies across the difficult country to Ambrizette and Ambriz, where there are no satisfactory harbors. In short, the problems and possibilities of this district are similar to those of the Belgian Congo which it adjoins.

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[5] *The African World*, Twentieth Annual Number, 1922–1923, pp. 88–89.

NEW RAINFALL MAPS OF BRAZIL

By Mark Jefferson
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Geographers and meteorologists have much interest in the distribution of Brazilian rainfall—and little knowledge of it.

The current maps are based on Voss's[1] map of 1907, which made use of data from 74 observation stations. Henrique Morize[2] has just published a new map, using 349 stations and of course showing great progress. But it must be remembered that Brazil is of about the size of the United States, and J. B. Kincer's admirable rainfall map of the United States of 1917 has 3600 stations behind it. We have still very scanty data for the rainfall of Brazil.

Morize's Contribution

However, for the very interesting region of northeastern Brazil—east of the 43rd meridian and north of Bahia—the offices of Defense against Drought (Inspectoria de Obras contra as Seccas) put in our hands through this work the result of 230 rainfall stations; also there is a considerable increase of regular meteorological stations throughout the country. The anti-drought observations have the further advantage of being fairly contemporaneous, falling mostly in the period 1912–1919, which enormously increases their value. The rainfall of any place varies so much from pentad to pentad that it is out of the question to try to ascertain its relation to the rainfall of some other locality if we have not contemporaneous records—the differences due to lack of correspondence in time often completely masking the differences that belong to the environment. A collection of long records of rainfall scattered throughout a century would therefore have nothing like the value of records made simultaneously for a much shorter period of years. Dr. Morize's map is based almost everywhere on five or six years of recent observations. This map is here reproduced (Fig. 1) beside Voss's map (Fig. 2). Inspection at once shows the improvement of the lines, removing that extreme smoothness that represents the simplicity of ignorance in the earlier map. The broad features of Brazilian rainfall are supposed to result from northeast trades in the north and southeast trades in the south. The doldrum zone between them shifts 10° or 12° north of the equator in July and south as far as the equator in January. The trades are competent rain makers when they blow against hilly and mountainous coasts; and so

[1] E. L. Voss: Die Niederschlagsverhältnisse von Südamerika, *Petermanns Mitt. Ergänzungsheft No. 157*, 1907.

[2] Henrique Morize: Contribuição ao estudo do clima do Brasil. 118 pp.; maps, diagrs. Minist. da Agric., Indust. e Commerc., Observatorio Nacional do Rio de Janeiro, 1922.

Dr. Morize's paper, as the title suggests, is not confined to rainfall but considers other elements of climate as well. He gives climatographs in Griffith Taylor's method for many Brazilian stations. The text is full of local descriptions of great value.

we looked for heavy rain in the Guianas and along the east coast of Brazil and found it there. The very strong ascent along the eastern border of the Andes is known to be clothed in a rain forest, and the trades should properly yield a very heavy downfall there, in spite of the great distance from the ocean.

The Amazon Basin

The level basin of the Amazon could derive its abundant rains only from the convectional thunderstorms of the doldrum belt. Appropriately this was known to extend north in July as far as Venezuela and to swing south-

MEAN ANNUAL RAINFALL OF BRAZIL

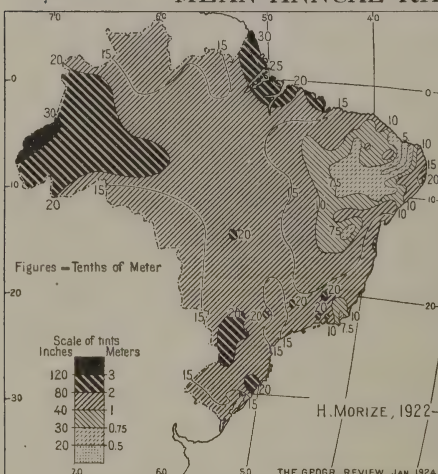

Fig. 1

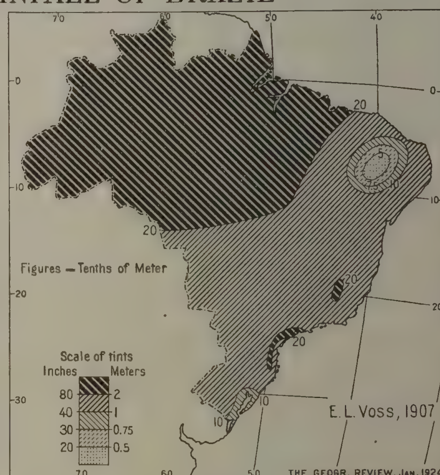

Fig. 2

Fig. 1—Rainfall map of Brazil by H. Morize, 1922.

Fig. 2—Rainfall map of Brazil by E. L. Voss, 1907.

ward in January, following the course of the doldrums. The old map showed nothing of the excessive rains on the eastern Andes, Voss having only 6½ years of observation at Manáos, 1300 miles east of the Andes, and 1 7/12 at Iquitos, 300 miles east of them. Iquitos showed 2600 millimeters and Manáos 2100, as our theory demanded; but this does not appear on Voss's map because it has no grades above 2000 millimeters. The resultant flat tint from the Atlantic across the Guiana highlands and all the Amazon plains to the high plateaus of the Andes did not and could not satisfy an inquiring mind. The rainfall across the Amazon basin cannot be so uniform. The 1922 map meets one's expectations admirably. Figure 3, which places a dot on every rainfall station that we have been able to identify, in order to show the great crowding of stations in the northeast, has room in the Amazon basin to carry a few annual amounts of rainfall expressed in tenths of a meter. Here we have no less than nine stations west of Obidos. The observations are seen to be of the same epoch as the antidrought series and to completely satisfy

expectation, as far as observations so widely scattered may be said to satisfy anything.

The details for the northeast are reproduced here in Figure 4, which is taken, with omission of town names and hydrography, from a recent publication of the Federal Office of Defense against Drought.[3]

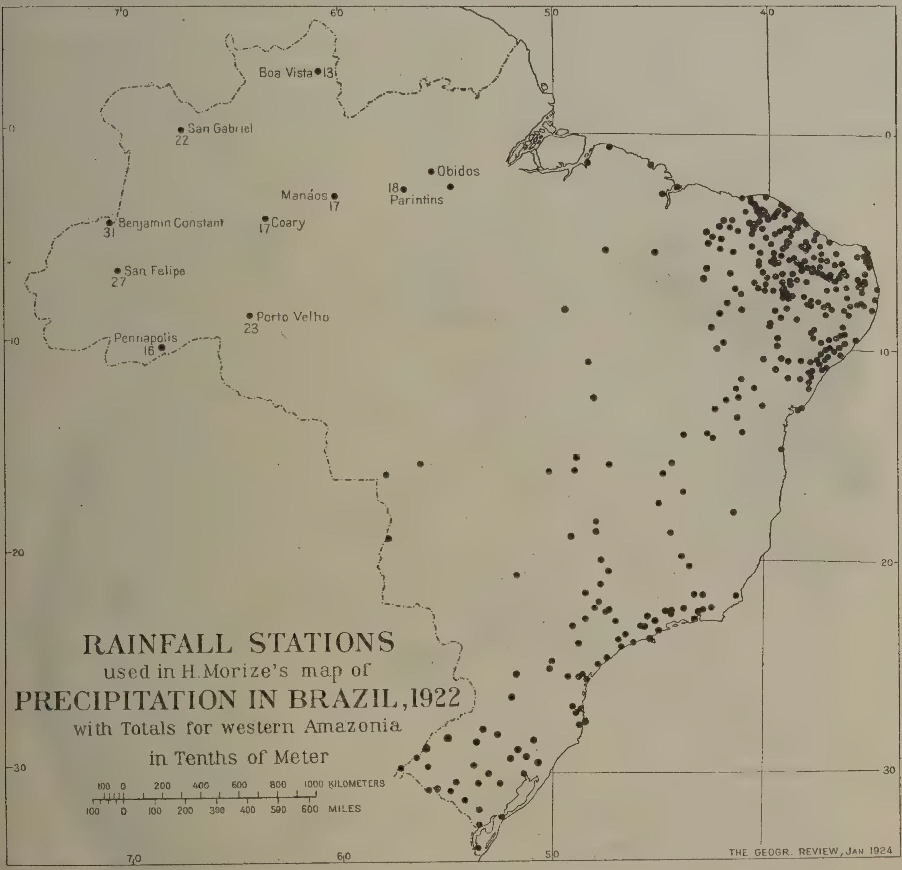

FIG. 3—Rainfall stations used in H. Morize's map of Brazilian rainfall (see Fig. 1).

THE SERTÃO

The southern part of the area with less than 600 millimeters of rain, including two of the four areas with less than 400, has the familiar position in the valley of the São Francisco River where it turns from a northeasterly to a southeasterly course a little east of the fortieth meridian. From this point the dry area extends eastward between the 8th and 9th parallels of south latitude as far as the 37th meridian and then north between the 36th and

[3] Dados pluviometricos relativos ao nordéste do Brasil (Periodo 1912–1920), collegidos pela Secção da Estatistica e Collecta de Dados Physicos e Economicos, e publicados sob a Direcção de C. M. Delgado de Carvalho, *Inspectoria Federal de Obras contra as Seccas, Publ. No. 47.*

37th meridians within about a hundred miles of the Atlantic, instead of being three hundred miles distant as formerly supposed. The largest dry areas lie in the states of Parahyba and Rio Grande do Norte. Two smaller patches with less than 600 millimeters occur in Ceará and Piauhy.

The northern part of Voss's oval of less than 500 millimeters rainfall, which I have put on this map as a heavy dotted line, is seen to be a region

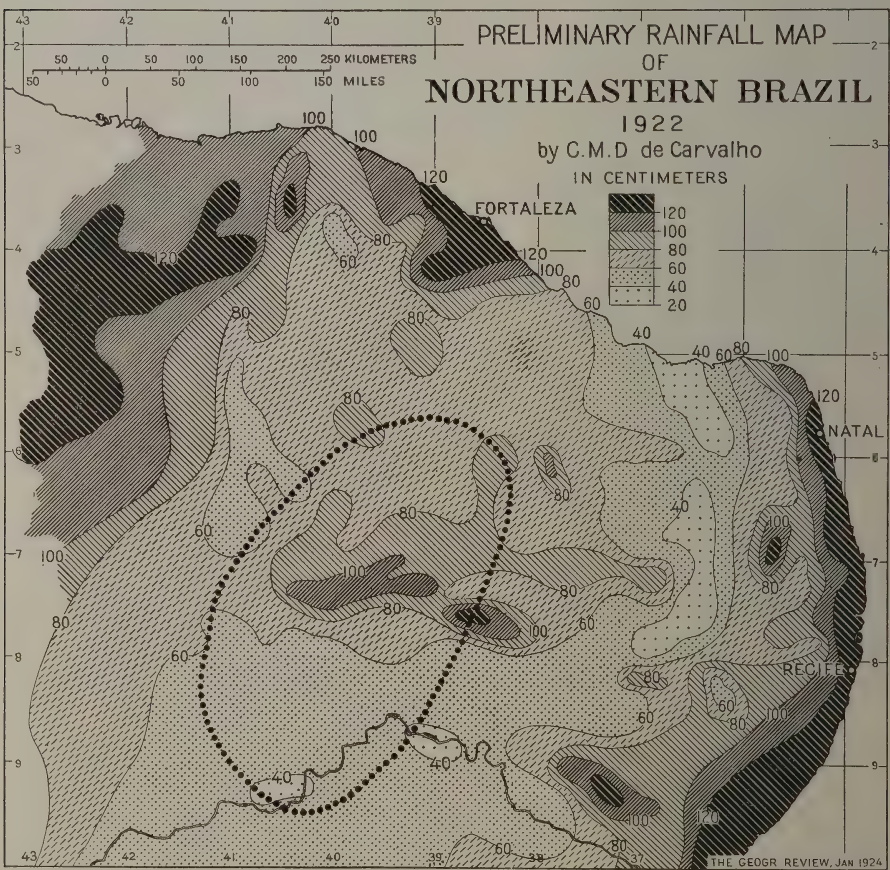

FIG. 4—Rainfall map of northeastern Brazil by C. M. Delgado de Carvalho based on a preliminary report of the Inspectoria Federal de Obras contra as Seccas, 1922.

of high precipitation, half of it having over 800 millimeters and one side reaching 1200.

In our latitudes aridity accompanies a rainfall less than 500 millimeters, but the evaporation resulting from higher temperatures so near the equator probably raises the amount of rain needed for safe growth of crops to an annual 700 or 800 millimeters. Probably the whole Sertão, with less than 800 millimeters of annual rain, has an arid type of vegetation. Certainly men perish there of hunger and thirst every few years, and great numbers are

obliged to abandon their homes during the bad season. September, October, and November are excessively dry in the normal year. Life is adjusted to that, but in abnormal years the rains of December and January also fail. Then famine appears exactly as in India when the monsoon fails to "break" on time. A rough general theory of these interior, drier areas in northeastern Brazil makes them dry because they are so flat-topped! There is heavy rain, 1500, 1700, and 2000 millimeters, on the east coast where the trades are uplifted—and thereby cooled—by ascent to the upland. The flat table-land of the interior is hot and dry because there is nothing to condense vapors of the trade winds. The São Francisco valley would seem to be a hollow into which the winds have to descend. One has to suppose a range of uplands toward the coast through which the river breaks in gorges as at the Falls of Paulo Affonso (longitude 38° W.). The difficulty with this theory is that some months, February, March, and April, have very considerable rain in this interior while the trades are still blowing on the east coast.

Conditions in this region are described by Baron Homem de Mello.[4] "The climate of the interior of the state [Ceará] is very hot and dry but of great healthfulness. In the coast zone the heat is moister but tempered by the sea breeze. The season of rains begins in February or March and ends in June. For the rest of the year it does not rain, the rivers stop, and the fields turn dry, which at times compels the inhabitants to come into the towns or to emigrate to other regions"—such as the rubber forests of the upper Amazon, whose main dependence for labor was on the Ceará men. The same work speaks of Piauhy, the state next west of Ceará. "The scourge of drought is felt in August and September, when the ground is transformed into a baked desert, while in favorable years, in the period of rains from February to June, nature reacquires its vigor rapidly."[5] No such distress arises in the valley of the São Francisco. There somewhat less rain falls in September and October, but there is no endangering of life.

The little city of Quixeramobim is in the heart of the Sertão of Ceará (latitude 5.3° S., longitude 39.9° W.). It has an average annual rainfall of 595 millimeters. Near the coast to the east the city of Natal has 1418 millimeters, owing to its exposure to the trades. Table I gives the details for the average year.

The winds at Natal are east and southeast, both directions trades, I suppose. The city of Natal lies about five miles inland on the south side of the estuary of the Jundiahy, which extends to the northeast from this point to the Atlantic. The south wind is a land wind. The east and southeast winds blow across five miles of low land but come from the sea and therefore contain much water vapor. This accounts well enough for Natal's greater rainfall if the high border of the plateau is near to lift and cool the air. But the variations in amount of rain are difficult to reconcile with the direction and force of the wind at different seasons.

[4] Geographia-atlas do Brazil e das cinco partes do mundo, F. Briquet et Cia., Rio de Janeiro, 1912, p. 23.
[5] *Ibid.*, p. 20.

The wind is strongest, according to the last column, in the dry months September, October, November, and December and is feeblest in the period of heavy rains. This does not seem to fit the idea of trades blowing on a shore with high land behind it and forced to give up their moisture by cooling on ascent. We should expect most rain with the stronger winds. As for Quixeramobim, it also has least wind—2.2 to 2.5 meters per second—in the wet months, March, April, May, and June, and most wind in the dry months, September to December, and those winds seem to be the trades. The people in the Sertão regard the trade as the

TABLE I— CLIMATES OF QUIXERAMOBIM AND NATAL

	Quixeramobim			Natal		
Months	Rainfall in Millimeters	Wind: Direction	Wind: Meters per Second	Rainfall in Millimeters	Wind: Direction	Wind: Beaufort
January	42	E & NE	3.7	60	E & SE	3.6
February	98	N & NW	3.0	123	E & SE	3.1
March	162	W & NW	2.5	143	E & SE	3.0
April	108	W & N	2.2	220	E & SE	3.0
May	80	SW & S	2.3	144	E & SE	3.1
June	43	S & W	2.5	316	E & SE	3.4
July	23	S & SW	2.9	200	E & SE	3.3
August	13	S & SE	3.6	124	SE & E	3.8
September	2	SE & E	4.6	36	SE & E	4.1
October	0	E & NE	4.9	12	E & SE	4.1
November	1	E & NE	4.9	14	E & SE	3.9
December	23	E & NE	4.7	26	E & SE	3.9

drought wind. If it keeps blowing they expect more drought. The direction of the lighter wind of the wet months, February to July, is northwest, west, or southwest. These observations were made by O. Weber from 1896 to 1905.[6] He was undoubtedly careful and competent, but the observers whom he trained to carry on the work after him from 1905 to 1919 report an east wind in every month at 7 A.M. and 2 P.M. and 9 P.M.

There are many notes by other observers to the effect that in the Sertão the trades give drought. Rain comes with variable, light winds from some westerly direction. From the *Boletim Meteorológico* I get the daily details of rainfall at Quixeramobim for the year 1910. The year was unusually wet, in the sense that it had an unusually heavy total rainfall; yet in July, August, September, and October no rain fell. The trades were remarkably well developed through the rainless months. September had regularly a southeast wind at 7 A.M. and 2 P.M. and a northeast wind at 9 P.M., with occasional

[6] Morize, *op. cit.*, p. 24.

substitutions of east for southeast. October showed almost the same conditions. The monthly amounts of rainfall that year were 122, 78, 297, 178, 274, 16, 0, 0, 0, 0, 23, 114; total 1102 millimeters.

In the unusually wet month March, on the contrary, when 297 millimeters of rain fell, the winds were from every direction. Only 3 days showed southeast, east, and northeast as the directions at the hours of observation. There were 8 northeast winds, 11 southeast, 20 east, 10 northwest, 3 southwest, 9 west, 9 south, 16 north, and 7 calms. The rain fell in thundershowers of small, irregular area. Clouds form readily in the dry season, too, but nothing comes of them. We may call them true doldrum rains; they are necessarily uncertain in time and amount. The surface of the Sertão appears to be an elevated plateau of granites and gneisses in which the very intermittent rivers have dug out poorly graded channels that partly dissect a flat upland. *Chapada* is the word applied to this level upland, and *chapadas* appear to occur all over the Sertão. The rivers have not well graded courses but descend at the borders of the Sertão by falls which carry off the waters of rainstorms with great rapidity. The anti-drought offices referred to above are constructing reservoirs (*açudes*) for saving these flood waters and have many finished already.[7]

Ferraz's Work

Besides Dr. Morize's paper there has recently come to hand from a bureau of the same department, the Bureau of Meteorology under the direction of Sampaio Ferraz, another interesting publication,[8] containing monthly averages of the meteorological elements at 73 full stations and 18 rain stations. A hasty examination shows that it contains the same statistics as Dr. Morize's paper, without the observations of the Defense against Drought stations, and that the observations have been looked over with an intent to criticize. In the main the figures are identical; but occasionally Ferraz has shortened a series by rejecting a year, noting some months as missing. The only considerable difference noted by the present writer was in the rainfall of Manáos, which Ferraz gives as 1954 millimeters and Morize as 1675. Table II contains the mean and absolute maximum temperatures and amount of rainfall of both series for Manáos.

Ferraz says Manáos is a third class station and that third class stations have their temperature observed at 7 A.M. and 9 P.M., means being obtained by the formula (7 A.M. + 9 P.M. + max. + min.) ÷ 4. Morize implies, if he is correctly understood, that Manáos had observations at 7 A.M., 2 P.M., and 9 P.M., and means were obtained by the formula (7 A.M. + 2 P.M. + 9 P.M.) ÷ 3, which would account for some small differences. As to the starred rainfall number 35.3, as compared with 55, only access to the records would decide which is right, but the sum 1954 is obviously an error.

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[7] Compare the note "Drought Relief Measures in Ceará" in the Geographical Record.

[8] Boletim de normaes: Observações meteorologicas feitas no ex-Observatorio Nacional, hoje Instituto Central do Rio de Janeiro, e nas Estações da rêde Nacional, Minist. da Agric., Indust. e Commerc., Direct. de meteorol., [Rio de Janeiro], 1922. See the review of this publication by E. G. Holt elsewhere in this number of the *Geographical Review*.

The "Boletim de Normaes" says in the preface that a "new Bureau of Meteorology was created in May, 1921," implying that it takes the place of the "old Bureau of Meteorology and Astronomy, established in November 1909, whose first and only Bulletin, for 1910, was published in 1914. Before, therefore, attending to the printing of the great bulk of data corresponding to the years 1911 to 1920 we resolved to publish at once the normal values of the existing series." This preface is dated December, 1921, and signed by Sampaio Ferraz.

Dr. Morize's paper calls itself on the title page "Work Extracted from the Historical, Geographical, and Ethnographical Dictionary of Brazil." It has a preface as such dated May, 1921, and an "Advertencia" that the Ministry of Agriculture and Commerce had decided that "the present work prepared for inclusion in the Historical, Geographical Dictionary of Brazil . . . should be reprinted. . . ." This is dated September, 1922. The individual copy of the Morize publication before me reached this country in the early spring, and that of the Ferraz publication in late summer. It looks as if Dr. Morize had published the material of the Normal Values with the authorization of his ministry before Dr. Ferraz published them, and in fuller form.[9]

TABLE II—MONTHLY TEMPERATURE AND RAINFALL AT MANÀOS

Months	According to Ferraz			According to Morize		
	Temperature		Rainfall in Millimeters	Temperature		Rainfall in Millimeters
	Mean	Abs. Max.		Mean	Abs. Max.	
January	26.7°	37°	210.9	27°	37°	211
February	26.9	36	203.3	26.9	36	203
March	26.6	36	204.6	26.9	36	205
April	26.7	34.6	214.3	26.9	34.6	214
May	26.8	35	167.7	26.9	35	168
June	26.8	35	99.5	27.1	35	100
July	27.2	34.2	46.2	27.3	34.2	46
August	27.6	35.6	33.0	27.8	35.6	33
September	28.2	37.2	35.3*	28.0	37.2	55
October	28.3	37.2	116.7	28.3	37.2	117
November	28.0	37.2	114.6	28.1	37.2	115
December	27.1	38.6	208	27.2	38.6	208
Year	27.2		1954.1	27.4		1675

Carvalho's Work

The "Dados Pluviometricos," from which we have redrawn Figure 4, is another work of great interest. It professes to be only a preliminary account of the simultaneous rainfall observations at 400 stations of the Defense

[9] Compare the statement by Mr. E. G. Holt in his review—Edit. Note.

against Drought for the period 1912–1919, with a map and the mean, maximum, and minimum rainfall of each month. It is, as the author, Carlos M. Delgado de Carvalho, says, a real treasure of science. Better still, it is to be followed soon by a "definitive publication which will have an explanatory introduction discussing the data contained in the tables and will study the pluviometry of the northeast with all possible minuteness. Annual and monthly maps, maps of means, percentages, and equal amplitudes will accompany the edition, which will also contain graphs and diagrams that are now being prepared." The places listed in the eight states of the northeast number 413, but for many of the places the data were not ready at time of printing. Data are printed for 291 stations, for 256 of them the whole eight years' data, 22 of them for seven years' data. The shortest series included are eight of five years each.

That there is no little difficulty in locating these stations even with the official resources of the Inspectoria is seen by the fact that latitude and longitude can be given for only 92. This defect will doubtless be remedied in the new work.

The map would have been more expressive if the names and rivers had been omitted, as has been done in the reproduction, and it is much to be desired that each station used for drawing the isohyetals should be indicated on the map by a distinct dot or circle, which can in turn be made identifiable on a list of stations arranged in order of latitude with the adopted annual value of the rainfall.

The three papers are a most timely addition to our knowledge of the geography of Brazil and are evidence, with the recently published sheets of the International Millionth Map, of fine stirrings of geographic activity in the Republic.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of November and December. The first regular monthly meeting of the American Geographical Society for the season of 1923–1924 was held on November 20, at the Engineering Societies' Building, 29 West Thirty-ninth Street. After a word of welcome to the Fellows of the Society on the part of President Greenough, the meeting was addressed by Major E. A. Powell who gave a description of his recent journey across northern Arabia and Mesopotamia to Persia and return. On December 18 the Society was addressed by Mr. Roy C. Andrews, of the Third Asiatic Expedition, on the results of his extraordinary explorations in Mongolia, a further account of which will be given in the April number of the *Review.*

Elections to Fellowship. At the November meeting of the Society, President Greenough presiding, there were presented with the approval of the Council the names of 211 candidates who were duly elected as Fellows of the Society.

Distribution of Title Page, Contents, and Index of Vol. 13 of the Geographical Review and of the Special Supplement to the October numbers, "Report of a Conference on Cycles." The title page, table of contents, and index for Volume 13 of the Geographical Review (1923), which is issued separately, is ready for distribution. Copies are sent to all institutions exchanging publications with the Society and to individuals who request that their names be put on a list for this purpose. The special supplement to the October Number may be obtained similarly. This is the "Report of a Conference on Cycles" held at the Carnegie Institution, Washington, December, 1922.

Presentation of the David Livingstone Centenary Medal to Professor Griffith Taylor. At a general session of the Australian meeting of the Pan-Pacific Scientific Congress (August 13–September 3, 1923) held at Sydney, August 30, Dr. Griffith Taylor, professor of geography at the University of Sydney, was presented with the David Livingstone Centenary Medal of the American Geographical Society. In presenting the medal Professor Nevin M. Fenneman, a delegate of the Society at the Congress, made reference to Professor Taylor's geographical work (see the *Geogr. Rev.*, July, 1923, p. 462) and also alluded to the fact that the first recipient of this medal, founded for contributions to geography in the southern hemisphere, was an Australian, Sir Douglas Mawson.

In responding Professor Taylor said in part: "It is an extraordinary thing to find one's work appreciated across the world." He added, "I thank Professor David for his help. Visiting delegates will realize why we set him rather apart from anybody else. He has helped so many of us."

The ceremony followed an important address by Professor Taylor on the future population of the world.

Millionth Map of Hispanic America. In the July number of the *Review* (Vol. 13, 1923, pp. 465–467) there was published a note on the twenty-eight sheets of the Millionth Map of Hispanic America which were then in hand by the Society and which form a part of its general program of geographical research in that field. The immediate aim is not to produce sheets as fast as possible but to carry compilation forward on a broad front to avoid repetition in the work of reference. There are now in press three sheets (in addition to the La Paz sheet published in 1923), and these will be ready for distribution late in January, 1924. They are named as follows: Baja California-Sur, N. G-12; Puno-Rio Beni, S. D-19; and Acre, S. C-19.

The Baja California-Sur takes in small portions of two adjoining sheets on the south and west so that the printed portion of the sheet overruns the conventional size by one

degree on the west and by one degree and ten minutes on the south. This was done to avoid printing three sheets instead of one where two of the sheets have only small areas of land and correspondingly large areas of sea. The adjoining sheet on the north (Baja California-Norte) for the same reason overruns its conventional limits one degree on the north, and the whole sheet is displaced eastward two degrees. Both sheets of paper will be of regulation size, however, and will "stack" with the other sheets in the series. The two together will form a convenient general map of the peninsula, the Gulf of California, the Sonoran region of Mexico, and a narrow strip of southern California and Arizona adjacent to the boundary. Because there were available through the recent field studies of N. H. Darton and the report of E. W. Nelson (Lower California and Its Natural Resources, *Memoirs Natl. Acad. of Sci.*, Vol. 16, 1921; reviewed by W. M. Davis, *Geogr. Rev.*, Vol. 11, 1921, pp. 551–562) an unusual amount of new and partly unpublished topographic detail and because also the Society wished to show both the advantages and the disadvantages of the two schemes of relief—color layers versus contours only—these two sheets will show contours in brown at 100 meter intervals and the ocean bottom by blue contours at 10, 20, 50, 100, 200, 500, 1000, 2000, 3000, and 4000 meters. The lower sheet, which is being printed first, strikingly reveals the advantages of contours where the land forms are known by detailed surveys. To follow the conventional scheme would be to give little physiographic information on account of the wide interval involved. Even if contours were interpolated between the boundaries of the color layer these contours would naturally be obscured by color and be far less striking to the eye than when they appear in brown against a background of white. The scale and texture of the topographic relief shown on the La Paz sheet are such that the conventional scheme of color layers admirably reveals the topography. This is not always the case, however; and, if the color scheme were rigidly followed, supplementary maps would need to be issued to illustrate the true nature of the physiographic detail. This is not a new observation, but there is constant need of reminder lest too much or too little be read into maps of the type that conform in general to the international scheme. It will always be true that different types of maps will be needed to show different types of relief. The contrast in the value of contours and color layers is also well shown on the Puno-Rio Beni sheet (Cuzco to Lake Titicaca and northeastward into the Amazon plains). Contours were first tried in the mountain section of this map, but they were so crowded that it proved far better to use color layers for general purposes. However, a small edition of this contour map has been printed for special use by scholars who may find it particularly helpful in studying the detailed relief in districts where accurate surveys permit its more exact expression. This plan of printing a small special edition of a base map free from color layers was followed also in the case of the La Paz sheet and has been well justified. The Puno-Rio Beni sheet and the La Paz sheet together give a cross section of the Andean realm in one of its widest parts and supply a new and far more accurate picture of the physiography than has been available hitherto. The Acre sheet has only a small area of mountainous country in its southwestern corner; elsewhere it shows plains country with hydrography and forest trails as the principal features. Each of the maps is accompanied by a leaflet giving the sources of information, and insets on each of the maps supply the facts of general location and reliability. The Lower California sheets were compiled from 36 cartographic sources, the Puno-Rio Beni from 64, and the Acre from 19.

Desert Trails of Atacama. Under this title the Society has issued Special Publication No. 5, by Isaiah Bowman, Director of the Society. It is now ready for general distribution and also for free distribution to Fellows of the Society. It describes the Desert of Atacama, the high Puna of Atacama, and portions of the adjacent territory on the east and north. It is primarily a study of frontier conditions in desert environments. Narrative and description are interwoven with geographical interpretation, and almost every important feature of the scenery and of desert life and settlement is illustrated by a photograph. In addition to about 90 photographs there are 20 maps and diagrams and one plate in

color. The chief features are: the conditions under which the shepherd folk of the high mountain and desert country live; the uncertain life of desert towns and irrigated oases; the use and control of water in desert valleys; the desert campaigns of the War of the Pacific (1879–1883); the working of geographic forces in Copiapó, an unusually interesting type of desert and frontier town; the roaring mountain of Toledo in Chile; the cattle trade across the Andean Cordillera between the Gran Chaco grasslands east of the mountains and the nitrate desert on the west; the border settlements of the eastern edge of the Puna of Atacama in Argentina; grassland and forest zones of the eastern mountain border; the trails and trade of the desert settlements at San Pedro de Atacama.

The general region which the book describes is illustrated by small black-and-white maps that accompany the text. In addition there will be published in 1924 three sheets of the Society's Millionth Map of Hispanic America that will give the relief and drainage in greater detail. They are named in order from north to south as follows: Iquique, Atacama, and Coquimbo. They cover the coast and mountain country between latitude 20° S. and 32° S. and, with the La Paz sheet already published, will furnish a complete set for the whole of the Desert of Atacama.

GEOGRAPHICAL RECORD

NORTH AMERICA

Progress in Red River Boundary Survey. The conditions of survey of the Red River boundary between Texas and Oklahoma are of considerable geographic importance. It will be recalled that the subject was discussed in the April number of the *Geographical Review* (Vol. 13, 1923, pp. 161–189, with maps). At a meeting of the Board of Surveys and Maps on Oct. 9, 1923, Mr. A. D. Kidder, one of the two Supreme Court Commissioners on the survey of the boundary, described the methods and problems involved. Advice had been broadly sought from the beginning, among the technical bureaus of the government, on questions of control, topography, and cadastral survey best suited to the requirements. After a conference on the general survey plan the opposing counsel and the Court concluded that, with three sovereign governments and many private claimants involved, and all pressing for an early settlement, a complete survey in the first instance was out of the question. As an alternative, a unit plan was adopted, the most urgent units (those in the oil-producing region) to be given first consideration. Different technical standards will be adopted for the different units. For the further description of the problem we quote Mr. Kidder as reported (by permission) in the minutes of the Board of Surveys and Maps:

"Obviously, a geodetic control must be obtained in order properly to correlate the several units, as well as for mapping requirements of each unit. Fortunately the oil field unit is situated only a few miles west of the 98th meridian, where the Coast and Geodetic Survey has already completed a meridional belt of precise triangulation. The order for the survey was entered March 12, after which arrangements were perfected with the Coast and Geodetic Survey for an extension of a belt of triangulation westward from the 98th meridian, covering the course of Red River where the first units are located. This belt averages about ten or twelve miles in width, and the first two units of the boundary were covered in seventeen stations. This work was carried forward by experienced geodetic engineers who promptly located the triangulation stations and made the required observations. Within the large geodetic figures a smaller triangulation scheme was laid out reaching between the Texas and Oklahoma bluffs, for the direct control of the boundary survey. At least one point of each triangle of the smaller system was located by precise observation from the main scheme stations. The latitude and longitude values of all control points have been furnished promptly to the boundary commissioners. The topographic survey is now in progress. The leveling circuits and field traverses were executed by experienced engineers of the Texas Reclamation Department, on the approved methods of the Geological Survey. The harmonious co-ordination of the cadastral survey was secured by the use of the same control monuments for all observations and measurements leading directly to the boundary bank. For this part of the work the General Land Office placed an experienced cadastral engineer and party at the disposal of the boundary commissioners. The report of the boundary survey cannot be filed until the completion of the topographic maps."

A Note on the Study of Karst Forms in the United States. While reviewing some of Professor Cvijić's recent work on the evolution of karst topography the writer's attention was called to a paper by Professor Beede, "The Cycle of Subterranean Drainage as Illustrated in the Bloomington, Indiana Quadrangle" published in the Proceedings of the Indiana Academy of Science, 1910. This paper, although not recent in date, is interesting since it shows a similar line of research pursued independently on the other side of the Atlantic.

The paper was originally designed to deal with a fairly small area, only 15 minutes square, but as his work proceeded the author realized that it involved general principles; his own words are "it would be impossible to treat the subjects in mind intelligently without outlining the cycle of subterranean erosion," therefore he enlarged the scope of his paper. In its final form the first part, comprising some 13 pages, deals with the cycle of subterranean drainage; while the latter part, approximately 18 pages, gives a description of the structure, physiographic history, and present-day land forms of the Bloomington quadrangle.

In the first part of the paper Professor Beede begins by a consideration of the conditions which make for rapid development in a karst region and then proceeds to outline the main

phases of evolution. Surface drainage is the initial stage, and the cycle of subterranean drainage may only be said to have begun when "the rapids of larger streams have deepened their valleys well across the plain, leaving their tributaries out of adjustment with them." Youth, the first stage of the cycle, is characterized by incipient "solution sinks" and slightly developed underground drainage. In maturity numerous sinks and underground drainage are well developed, and at the exits of the underground streams caverns are already beginning to collapse. Old age is marked by the occurrence of numerous "collapse sinks" together with watercourses laid bare by collapse. The final state of the region is a peneplain.

The second part of the paper should prove valuable to American students as an aid in field work in the karst region of Indiana. Example after example of karst topography is dealt with in so careful a manner that there should be no difficulty in finding actual examples of each characteristic feature. Numerous photographs help those who are unable to go over the ground themselves.

The limitations of Professor Beede's paper are those imposed by geographic conditions. In his region there is not that enormous thickness of limestone, nor the complicated structural conditions, which enabled Professor Cvijić to cover the whole field of possible karst development (as far as one at present can judge the extension of this field). In particular the great inland basins, which Cvijić calls poljes, and various modifications due to the foundering of immense faulted blocks, together with features developed on coasts, are not mentioned in Professor Beede's paper. But the main features of the cycle of erosion in a karst region, as worked out by Professor Beede, are the same as those formulated by Professor Cvijić.

E. M. Sanders

Karst topography in Northwestern Porto Rico. A peculiar form of karst topography is described by Bela Hubbard from northwestern Porto Rico (Geology of the Lares District, *Sci. Surv. of Porto Rico and the Virgin Islands*, Vol. 2, Part 1, New York, 1923). This is the so-called sink-hole-*pepino* hill country of the northern coastal plain. In the east it occupies the whole of the plain, in the western section it is developed on certain belts (see the geological map accompanying the report; unfortunately the legend has been in part transposed). The elevated coastal plain is composed mostly of limestone characterized by underground drainage. With the exception of the rivers Guajataca and Camuy, which cross the limestone belts by narrow canyons, nine-tenths of all the drainage is subterranean. It is possible that these two streams formerly flowed underground, the present canyons being formed by caving. Even now the course of the Camuy is subterranean across the Cibao belt (soft chalky limestone). "After a continuous 24 hours of rain it was noted that there was practically no surface run-off on the Cibao prairie not even the smallest rivulet being in evidence." The *pepino* or haystack hills are described thus: "roughly conical or moundshaped. In size, they range from small mounds less than 20 feet high, to hills at least 300 feet high. They are, where best developed, closely crowded, the intervening spaces being occupied by sink holes of elongate or irregular pattern. In these belts of *pepino* hills, one often cannot find level spaces large enough to pitch a tent on. All trails and cart roads meander around the steep sides of the hills, avoiding the sink holes." In explaining the origin of the *pepino* hills it is noted that they are not characteristic of the impure limestones or hard limestones of flinty texture; they do not occur in the most arid section; they are best developed where the limestone is most cavernous; they often show a linear north-south grouping with intervening lanes of sink holes; the hills are steepest on the western slopes, where the solvent action of the afternoon showers falling on a surface of higher temperature is increased. Thus they appear to arise from a combination of extensive underground solution and rapid surface solution in conjunction with certain special lithological and climatic factors.

The Physiography of Porto Rico. The physical features of Porto Rico have been systematically described by A. K. Lobeck and published by the New York Academy of Sciences under the title of "The Physiography of Porto Rico" as Part IV, Vol. 1, of the Scientific Survey of Porto Rico and the Virgin Islands, 1922. The main conclusions are summarized in five block diagrams reproduced herewith by courtesy of the Academy. The right-hand margin of each diagram represents the northern side of the island. The descriptions beneath the series outline the sequence of physical changes that have produced the existing topographic forms.

In addition to the above diagrams there is a general location and railway map and a map showing the physiographic regions of the island. A block diagram of the Guanico district,

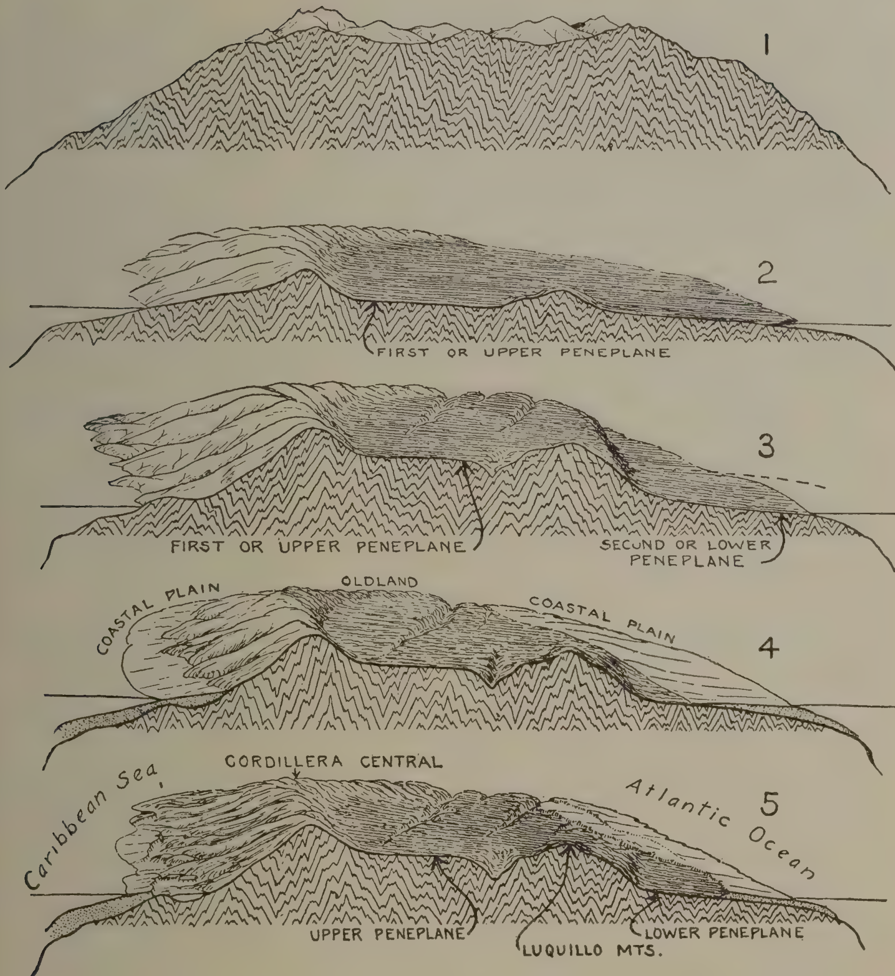

FIG. 1—The main stages in the physiographic development of Porto Rico.

1. The initial complex mountain mass of Porto Rico.

2. After the first peneplanation. Showing the monadnock group forming the Luquillo Mountains and the Cordillera Central.

3. The peneplane has been uplifted and dissected and a second lower peneplane has been formed along the north side of the island.

4. The whole island has been lowered, its northern and southern flanks have been covered with coastal-plain deposits, and the mass as a whole has again been raised.

5. Dissection of the coastal plain has taken place. Distinct cuestas appear on both the north and south sides of the island.

on the southern coast near its western end, shows Guanico Harbor as an arm of the sea extended by drowning as far as the inner lowland through a gap in two typical cuestas of the fringing coastal plain. The photographs are not only well selected, but most of them have their features labeled, to the reader's great advantage. The report is another excellent illustration of the great advantage that lies in the description of physiographic features in a systematic way and in technical terms instead of in the rambling, individualistic, and unscientific way more commonly followed.

SOUTH AMERICA

Drought Relief Measures in Ceará, In Professor Jefferson's discussion of the new rainfall maps of Brazil (See pp. 127–135) reference is made to the notorious droughts to which the northeastern part of the country (the Sertão) is subjected. A recent article "Irrigation In Brazil" by Ira W. McConnell (*Bull. Pan Amer. Union*, Jan., 1923) describes the measures taken for permanent relief against this condition in the state of Ceará, the chief sufferer. Mr. McConnell's paragraph on the rainfall is worth quoting:

"The rainy season begins normally in December and lasts until April or May; then follows a dry season until the following rains at the end of the year. In most years there will be light local showers in October, known as "Chuvas de Cajú" (Cajú rains), so called because they occur at the time of blossom of a popular fruit called "Cajú." These rains are of negligible value from an agricultural standpoint but are beneficial to the pastoral industry. The rainy season may be delayed until January or February. As the season for rain advances without it, the people anxiously scan the horizon for signs of the much-needed moisture, and if by March 19, which is the feast day of San José, there are no rains, they abandon hope for that year and set about such remedies as they may to wear through the long, lean, and hungry months until the next rains."

On the other hand the climate is healthful, and the valley soils are fertile and susceptible of varied production, including among exportable crops cotton of very fine grade. The state is comparatively populous (over 1,300,000 persons, or 32.7 to the square mile, according to the 1920 census) thus showing a notable resiliency to disaster. In the great drought of 1877–1879 the state is estimated to have lost over 300,000 persons and 75 per cent of the cattle. Each succeeding drought has been followed by considerable emigration. After the drought of 1915, according to C. M. Delgado de Carvalho (Météorologie du Brésil, 1917), 22,000 persons left Ceará and 8000 died.

It was as a result of the drought of 1877–1879 that permanent relief works were initiated, the well-known "Inspectoria de Obras Contra as Seccas" being organized in 1909. The first work to be undertaken was construction of railroads and highways to aid in general economic development as well as to facilitate the prosecution of relief measures. The next step is reservoir construction. The broken topography lends itself well to the purpose, but the character of the precipitation makes the problem difficult. Fortaleza, situated in the best part of the area (compare the map, Fig. 4, p. 130), has a mean annual rainfall (1849–1917) of 56 inches; the mean for ten years of drought was 24 inches; for five flood years 96 inches. Quixeramobim, an inland station, had 6 inches in 1914–1915 (figures for the crop year) and 57 inches in 1916–1917. Practically all the run-off occurs during the six months or less of the rainy season. Provision must be made for the recurrence of partial droughts every five or six years and also for the times of great drought when the reservoirs will be called upon to furnish supplies for a 30-month period without replenishment. Hence complete storage is called for. Five dams now under construction by American firms will have a storage capacity of over 4,000,000,000 cubic meters of water. Other contracts are in English hands. A map on the scale of 1:1,000,000 shows railroads, highways, and reservoirs completed and under construction in the region under discussion.

The Santa Marta Region of Colombia as a Faunal Island. Several recent biological expeditions to the Republic of Colombia have added greatly to our knowledge of the fauna and flora of a region that, to the ecologist and biologist, is one of the most interesting in South America. Colombia lies almost entirely between latitude 1° and 11° N. Latitude has, therefore, little or no influence upon the distribution of plant or animal life. Altitude and precipitation are the controlling factors, and, in a region where within comparatively small areas the topography varies from sea-level savanas to snow-capped mountains and the rainfall from almost perpetual dryness to 400 inches annual precipitation, much diversity in life forms is to be expected. Four life zones have been recognized: Tropical, from sea level to about 5000 feet; Subtropical, from approximately 5000 to 9000 feet; Temperate, from 9000 to 12,000 feet; and Páramo, above 12,000 feet. They have been described by Frank M. Chapman in his monograph on the distribution of bird life in Colombia (*Bull. Amer. Museum of Nat. Hist.*, Vol. 36, 1917).

Two recent reports deal with the little-known Santa Marta region. One by Dr. Alexander G. Ruthven on "The Amphibians and Reptiles of the Sierra Nevada de Santa Marta, Colombia" (*Univ. of Michigan Museum of Zoology Misc. Publs. No. 8*, 1922) is based on his expeditions of 1913 and 1920. It includes an interesting description of the geography of the

region by M. A. Carriker, Jr. Mr. Carriker, who has resided in the region for many years, is also joint author with W. E. Clyde Todd of "The Birds of the Santa Marta Region of Colombia: A Study in Altitudinal Distribution" (*Annals Carnegie Museum*, Vol. 14, 1922). The Andean chain divides at the southern boundary of Colombia into three branches, known as the Western, Central, and Eastern Cordilleras. In addition to these is the Sierra Nevada de Santa Marta, a range lying parallel to the north coast and practically at right angles to the Eastern Cordillera. This range has no physiographic or geologic connection with the cordilleras, and evidence is abundant as to its former connection with the now partly submerged range which forms the near-by islands of the Caribbean. The three cordilleras, by virtue of the fact that they are branches of the main chain of the Andes, have their life zones more or less closely related; but the Sierra Nevada de Santa Marta is, at least above the 4500-foot contour, completely isolated from the cordilleras by the practically conterminous valleys of the Río César and Río Ranchería. The Tropical life zone, since its controlling factor is latitude as well as altitude, is continuous for the whole country; but above that zone Santa Marta may be considered a faunal island. The depauperate fauna of these upper zones as compared with the fauna of the cordilleras is one of the recognized characteristics of islands. Fully three-fourths of the bird life of the Santa Marta region is limited to the Tropical life zone. Even in this zone there is a sparcity of bird species as compared with other Tropical life zone regions of northern South America, giving added substantiation to the theory that during the time when bird evolution was at its height the Santa Marta region was a peninsula practically cut off by water except on the east, whence came the greater part of its original bird life. Later, as land formed south and east, more forms came in—a process which is still going on.

EUROPE

Statistics on the New Baltic States. Through the interpretation of recent statistics an article by Henri Bunle on Esthonia, Latvia, and Lithuania in the *Bulletin de la Statistique Générale de la France et du Service d'Observation des Prix* (Vol. 12, 1923, pp. 395–439) throws light on contemporary economic and geographical problems of these three Baltic states. The World War, though bringing political independence and much-needed agrarian reforms, also wrought incalculable damage, from which recovery is only now beginning to be felt.

There has been a fairly general falling off of population, the result partly of losses on the battle field and partly of the complete dislocation of economic life. The number of people in Esthonia is said to have diminished between 1917 and 1922 from 1,680,000 to 1,110,000; in Latvia from 2,550,000 in 1914 to 1,596,000 in 1920, though the figure had risen to 1,850,000 by 1922. Lithuania, not counting the territory awarded to Poland in March, 1923, lost the least. Her population in 1921 was 2,167,000, the decline between 1914 and 1920 having been only 325,000. Whereas Riga, the principal city of Latvia, had a population of 520,000 in 1914, this was reduced to 185,000 in 1920; by 1922, however, it had remounted to 270,000.

Manufacturing and mining are of no great significance in these states. What manufactures there are have suffered most through the elimination of the Russian markets. Of greater importance are the industries of field and forest and foreign commerce.

The most important industries of Esthonia and Latvia are forestry and stock raising: in Esthonia a fifth of the total superficial area exclusive of water is given over to forests, approximately two fifths to pasturage and meadowland, and slightly less than a quarter to arable land. Somewhat more than a quarter of Latvia is forested, a third is pastures and meadows; there is about the same area of arable land as of forests. The principal field crops of both Esthonia and Latvia are rye, oats, barley, and potatoes (used mainly for distillation); but the area actually under cultivation has been greatly diminished as a result of the war. The same is true in Lithuania. Here field agriculture is relatively more important than in its northern neighbors, arable land occupying nearly a half of the surface. But only a half of this arable land is now under cultivation. Seventeen per cent of Lithuania is forested, and 26 per cent meadowland and pastures. Efforts are being made to revive the stock industry, which was virtually ruined by German requisitions and deportations.

Before the war, proprietorship of lands in these states was largely in the hands of a minority of nobles who were exempt from taxation. The newly constituted governments have put through drastic agrarian reforms, splitting up the great estates and dividing them among the peasants. An attempt is being made to create a class of small farmers. The forests, however, are being held by the state.

Prior to 1914 the Russian provinces which now form Esthonia and Latvia were important primarily from the commercial point of view, as gateways to Russia. The ports, while not entirely free from obstruction by ice, were, nevertheless, open to commerce for longer periods each year than Petrograd. Between 1908 and 1913, of the total foreign commerce flowing through the Baltic ports of Russia (exclusive of Finland) more than two-thirds passed through Latvia and Esthonia, and only 31.7 per cent through Petrograd. The war and the disordered state of Russia have sadly reduced this trade. The foreign commerce of Latvia has fallen to one tenth of its pre-war volume. While internal reconstruction within the Baltic states is bringing about some measure of recovery from the desperate situation of 1919, only with the reëstablishment of stability in Russia can there be much hope for a return to the commercial and industrial prosperity of the years before 1914.

A Regional Division of France, 1790. An article by Henri Mettrier in a recent number of the *Bulletin de la Section de Géographie* (Vol. 37, 1922, pp. 149–203) is devoted to a regional subdivision of France made by Dumez and Chanlaire in connection with their famous "Atlas national de France" published in 1790 and the years following. This atlas was one of several cartographic publications compiled on the basis of Cassini's great survey of France. It was intended to illustrate the revolutionary reorganization of France worked out by Sieyès and put through the National Assembly in 1790 whereby, in place of the confusing complex of provinces, generalities, intendancies, and other units of the *ancien régime*, there was substitued the division into *départements*, *arrondissements*, and *cantons* which has lasted to the present day.

Dumez and Chanlaire conceived of France as essentially square. They split it up into nine regions forming three tiers of three regions each. Each of the latter, in turn, was divided into three countries (*contrées*), and each country into three départements. The scheme was not altogether original; its authors acknowledged their debt to Robert de Hesseln who, in 1784, had divided France into nine great divisions. De Hesseln's major divisions were perfect squares, each subdivided into smaller squares, which in turn were resubdivided into still smaller squares, and so on down to a fundamental square with sides of eight *toises* (51 feet). De Hesseln's ambition was directed toward the eventual production of a minute topographic description of France based upon these artificial rectangles. The limits of Dumez and Chanlaire's regions and countries, however, being determined by the boundaries of the départements, were less geometric than those of de Hesseln though fully as arbitrary. They certainly bore no relation to any physiographic, economic, or human provinces and hence cannot be compared with the natural or geographic regions of modern geographers. At first the authors of these regions hoped that the National Assembly might adopt their divisions for administrative purposes. Fear of overconcentration of authority, however, prevailed in France at this time. Suggestions favoring the establishment of larger administrative units than the département were looked upon with much suspicion. Dumez and Chanlaire soon saw fit to go out of their way in emphasizing the non-political character of their scheme and stressing its value as a mnemonic aid for the young in the difficult task of learning the names and positions of the eighty-three départements. It is curious to note, however, that until as late as 1919 the Ministry of Agriculture employed a classification of the départements into nine regions corresponding exactly to Dumez and Chanlaire's regions as finally defined in 1792. M. Mettrier believes that the classification must originally have been copied direct from a map in the "Atlas national."

Equality was one of the three great watchwords of the Revolution. Frenchmen sought to attain not only political and social equality among individuals but also territorial equality among the administrative subdivisions of their country, and it was merely a further application of the principle of equality that led to the arithmetical grouping of départements in the "Atlas national" and the consequent invention of regions having no reality except in the minds of their makers. Science in the eighteenth century was largely deductive. Men were so deeply absorbed in the elaboration of systems deduced from preconceived hypotheses that they frequently failed to connect their hypotheses with the facts of nature. In geography this showed itself in schemes like those of de Hesseln and of Dumez and Chanlaire. These are graphic illustrations of the tendencies of political and scientific thought prevalent in France during years fully as interesting for their intellectual vagaries as for the dramatic events that marked them.

The Agrarian Problem in Sicily. Most of the interior of Sicily is given over to *latifundia*, or great estates, ranging from 150 to 1000 hectares in extent (370 to 2471 acres). Not more

than 787 persons own about a third of the entire area covered by the cadastral survey of the island, and nearly one sixth is in the hands of 173 individuals Unlike the *haciendas* of Mexico (see G. M. McBride: The Land Systems of Mexico, *Amer. Geogr. Soc. Research Ser.*, No. 12, New York, 1923), the *latifundia* do not normally include the peasant villages with the intensively cultivated fields, orchards, and gardens surrounding them. The characteristic great estate of Sicily forms generally a tract of lonely, uninhabited country devoted to stock raising and to the extensive cultivation of cereals. In its midst usually there is merely a cluster of farm buildings and the dwelling house of the owner (often an absentee landlord).

Professor Giovanni Lorenzoni, of the University of Siena, in an article entitled "Latifundia in Sicily and their Possible Transformation" (*Internal. Rev. of Agric. Economics*, Vol. 1 (N. S.), 1923, pp. 316–349) asserts that in the "struggle between the *latifundia* and the oases of intensive cultivation lies the whole drama of the inland zone of the island and, it may be said, of all Sicily." During times of prosperity the oases grow in size and numbers; in "periods of decadence and poverty" they shrink, and the islands that have temporarily emerged from the sea of the *latifundia* "are covered once again."

The main reason for the existence of these estates is to be sought in the dryness of the climate and consequent shortage and uneven distribution of water. The widespread occurrence of clayey soil must also be taken into account. Over large tracts the only profitable crops that can be grown without irrigation are certain cereals "and especially winter wheat, alternating with natural pasture or with pulse crops cut once only in the year." Cultivation is carried on during the autumn and winter. In summer the land is abandoned, partly because it is then unproductive and partly because of the malaria prevalent during the hot months.

As now operated the *latifundia* bring many evils to the social and economic life of the community. These evils all tend to work toward the perpetuation of the system, so that we have a series of vicious circles. For example, the concentration of population in the larger inhabited centers and the abandonment of most of the countryside to *latifundia* is due in part to malaria. On the other hand malarial mosquitoes seem to breed most plentifully in those waste places where the population is the least. The scarcity of good local roads prevents the introduction of machinery and equipment for the construction of works of improvement on the estates. And yet the lack of easy communications is itself a result of the backward development of these very estates. The insecurity of property, especially of cattle, due to the uncertainty of public safety, is likewise partly a cause for and partly an effect of existing conditions.

Professor Lorenzoni does not hope for any immediate or sudden amelioration of these conditions. Rather than by breaking up the *latifundia*, he thinks that greater productivity may be attained by leaving them intact. On the other hand, he is convinced that there is full justification from the social point of view for the enactment of legislation empowering the state to force the landholders either to undertake the improvement of their estates or else to give them up to others who will do so. It is especially desirable that systems of irrigation be introduced, together with the planting of fruit trees and the more intensive and scientific cultivation of cereals. In any case it must be a long process before the *latifundia* are transformed into agricultural units that will be a benefit rather than a menace to the community and nation.

Phases of Karst Evolution in Moravia. Professor Cvijić has recently studied the karst lands of Moravia with a view to testing his theories of the development of karst topography. The results of his research are published by the Academy of Sciences of Belgrade, *Glas*, 108, 1923 (the article is in Serbian with a résumé and explanations of the diagrams in French).

The karst lands of Bohemia which are dealt with in this article occur to the north of Brno (Brünn) near Blansko, a district in which limestone of Devonian age is overlain by a thin covering of clay produced by weathering. In some sections the limestone is overlain with sands and clays of Secondary rock. In consequence the land forms are different from those of the Dinaric karst. The size of the sink holes is restricted because the clay forms patches of impermeable covering on the surface. Further the existence of much loose material causes the blocking of sink holes in times of heavy rain or of the melting of the snow, and temporary lakes and swamps are the result. The grander features of the Dinaric karst, such as the great rocky dolines, are lacking and the lapiés, uvalas, and poljes are nowhere seen in Moravia.

Although the surface forms are different, yet the main course of evolution seems to be similar to that of the Dinaric lands. A series of caverns at different levels enable one to trace

successive stages of their formation and show indisputably that the mechanical action of water has had much to do in their formation. Professor Cvijić insists upon the greater wear and tear of mechanical erosion and the lessening importance of dissolution as a disrupting agency as the cycle proceeds. The moment a subterranean river is formed it is the mechanical action that predominates.

Various other features, in particular dry valleys and ponors together with the calcareous deposits, make the region an excellent test case for the theories of karst evolution which Professor Cvijić has originated and which are upheld by his researches in this region.

E. M. Sanders

Italian Cartography of the Sixteenth and Early Seventeenth Centuries and a Sixteenth Century Description of Italy. The period before the middle of the seventeenth century has been called the *pregeodetic* period in the history of cartography. Though something was then known of the principles of triangulation and of the astronomical determination of positions, topographic maps were almost universally based upon route measurements, estimates, and other non-geodetic calculations. Detailed maps, however, were produced, especially after 1500; and some of these, more particularly those of the Italian and Dutch schools, were remarkably accurate considering the methods used. Something of the mathematical precision which could not be attained because of the lack of instrumental surveys, was in part made up for by the profoundly scholarly and critical studies that went into cartographic compilation.

Italian students have of late been devoting much attention to the development of the cartography of Italy between the mid-fifteenth and mid-seventeenth centuries. At the suggestion of Professor Roberto Almagià of the University of Rome, now a leading authority in this field, the Eighth Italian Geographical Congress approved a project for the publication of a *Corpus*, or collection, of photographic facsimiles of maps of Italy of this period something on the lines of Nordenskiöld's *Facsimile Atlas* and *Periplus* (*Atti VIII Congr. Geogr. Italiano tenuto in Firenze dal 29 Marzo al 6 Aprile, 1921*, Florence, 1922, pp. 125–128). It is to be sincerely hoped that this project may be realized, for at the present time the maps are so widely scattered through the archives and libraries of the peninsula that a synthetic study of them is all but impossible.

A magnificent volume by Professor Almagià appeared in 1922 under the title "L' 'Italia' di Giovanni Antonio Magini e la cartografia dell'Italia nei secoli xvi e xvii" (*Comitato Geogr. Nazionale Italiano Pubbl. No. 1*, Naples and Florence). The Paduan, G. A. Magini, born in 1555 and from 1588 until his death in 1617 professor of astronomy at the University of Bologna, was the foremost Italian map maker of his day. Besides the great atlas of Italy, "Italia," he was the editor of a new edition of Ptolemy's "Geography" (Venice, 1596), of various astronomical and astrological works, and of a general map of Italy dating from 1608 (see *Geogr. Rev.*, Vol. 10, 1920, p. 418).

Professor Almagià's volume is an exhaustive and learned study of the "Italia," its sources and influence upon the future. Incidentally the author brings together such a wealth of material on Magini's predecessors and successors that his work may also be regarded as a general treatise on the Italian cartography of the age.

Magini's atlas consists of sixty-one plates preceded by a brief descriptive text. From his study of its sources, Professor Almagià concludes that little more than a fifth of the data was drawn from previously printed materials. The remainder was derived from official unpublished documents and from information which Magini was enabled to gather through friendly personal connections with Prince Francesco Gonzaga and other powerful men. Some idea of the infinite care which the cartographer exercised may be inferred from the following comments which he made upon his work: "I have, then, tried with all care to procure tracings and designs of all parts of this province [and of Italy], not contenting myself with merely one or two for each part but only with all that it was possible to obtain through personal requests and through having requests for them made to the Princes and Lords of the states of Italy and to engineers and men of genius (*virtuosi*) who have possession of them." After drawing up a preliminary sheet for each map, Magini would submit it for criticism to competent local authorities: "Nor have I been satisfied with showing a sheet to one alone, but to many in order that they might confirm whatever I have set down in the course of this laborious work. . . ."

So detailed, so artistically and clearly drawn, and so reliable were Magini's maps that the "Italia" went through many editions, and its plates were frequently incorporated into later

atlases and copied by later cartographers. They were used in the atlases of Mercator, Jansson, Bleau, Greuter, and Sanson; and Magini's influence was felt even in the early eighteenth century.

In connection with his new edition of Ptolemy's "Geography," Magini wrote a commentary on the modern maps. Though he added much original material, his main source for the historical notices in this commentary was the "Descrittione de tutta Italia" of Leandro Alberti, first published in 1551. This work is the subject of an article by Professor G. B. Roletto "Le cognizioni geografiche di Leandro Alberti," *Boll. Reale Soc. Geogr. Italiana*, Ser. 5, Vol. 11, 1922, pp. 455–485). Alberti, a Dominican friar, traveled widely through Italy in the twenties and thirties of the sixteenth century. He found his inspiration in Flavio Biondo's "Italia illustrata," a great Latin description of the antiquities and historical monuments of the country written by one of the famous humanists of the preceding century (see J. C. Husslein: Flavio Biondo als Geograph des Frühhumanismus (diss.), Würzburg, 1901). Alberti, however, was a keener observer than Biondo of contemporary conditions, and the "Descrittione" is primarily of value for the detailed account it gives of the agriculture, mining, forestry, and trade of the Italy of the time. Professor Roletto has introduced in his article a most interesting series of sketch maps showing the distribution of various products, lines of communication, ports, and commercial centers as Alberti describes them.

Alberti's and Magini's works are important documents not only for the light they shed on the development of geographical science but also as sources for the study of the human geography of Italy during the age of the Renaissance.

AFRICA

The Political Significance of Abyssinia. The only African people who have been able continuously to maintain their national independence from very early times are the Abyssinians, or Ethiopians, as they call themselves. Their country stands remote upon mountains and plateaus, cut off from the outside world by deserts and arid plains to north, east, and south, and to the west by the great swamps of the Nile valley. Its dominant race is a proud and ancient folk of Hamitic stock. Members of its ruling family would trace their lineage back to Solomon and the Queen of Sheba. Its religion, a primitive form of Christianity closely related to the Coptic Christianity of Egypt, has bound the people together through the richness of traditions and the fanatic loyalty it inspired while the floods of Islam were sweeping over the surrounding lowlands.

Colonizing nations of Europe have looked covetously upon the vast and undeveloped resources of Abyssinia, but the Ethiopian's ability to defend himself and the mutual jealousies of the Europeans have prevented any one of these nations from gaining a foothold upon her soil. Italy remembers with bitterness Crispi's ill-fated attempt to convert Menelik's realm into an Italian protectorate, an attempt which resulted in the crushing Italian defeat at Adowa in 1896. Before the World War Germany dreamed of Abyssinia as a sphere of economic influence ultimately to become a colony, and during the war German intrigue was in some degree responsible for civil strife which threatened to nullify the magnificent achievement of Menelik in forging a strong and united nation from a hostile aggregation of feudal principalities. The most elaborate, thorough, and informative work on the country, a vast treatise in three volumes dealing with all aspects of Abyssinian geography and life, came from the pen of a German traveler (G. K. Rein: Abessinien, eine Landeskunde nach Reisen und Studien in den Jahren 1907–13, 3 vols., Berlin, 1918–1920. These volumes contain useful bibliographies. See also Giuseppe Fumagalli: Bibliografia etiopica, Milan, 1893).

Since the elimination of German ambitions in the African colonial field, France, Great Britain, and Italy have been far from united in their attitude toward Abyssinia. Completely surrounded by colonies of these nations, the Ethiopian state will become ever more the primary source of the economic prosperity of these colonies. Were she to be broken up politically, the value of these lean lands would be immeasurably increased by the acquisition of blocks of the Abyssinian hinterland. But if she is able to maintain her independence, only through the development of the transit trade in commodities from her rich fields, forests, and mines may any considerable commercial prosperity be hoped for in the lands immediately adjoining.

By far the greater extent of Abyssinia's frontiers faces British territory: the Anglo-Egyptian Sudan and Uganda on the west, Kenya Colony on the South, and British Somaliland on the east. Italian territory comes second, with Eritrea on the north and Italian So-

maliland on the southeast; and French territory takes the last place with the small area of French Somaliland on the northeast. The position of the French, however, is altogether unique. Though theirs is the smallest adjacent colony and is separated from the rich highlands of central Abyssinia by a tract of desert, there runs through French Somaliland the main link of commercial communication between Abyssinia and the outside world. This is a railway (finally completed in 1917, though it had operated as far as Dire Dawa for many years before) from Jibuti, the port of French Somaliland to Addis Ababa, the capital. Of the total border line of Abyssinia, only about 9 per cent faces French territory, yet no less than 71 per cent of the foreign commerce of that country flowed through French Somaliland in 1917 (M. Boucoiran: La situation économique de l' Éthiopie, *Renseign. Colon.* (*Suppl. à l' Afrique Française*), 1918, pp. 177–204; reference on p. 188). It is to be supposed, therefore, that France would gain little and lose much through the partition of Abyssinia. France's immediate hinterland forms one of the least desirable parts of that country: the acquisition of the richer tracts by the Italians and British would unquestionably spell ruin for the commerce of Jibuti.

The British, on the other hand, would gain a great deal were they able to establish control over the western and southern parts of the Ethiopian realm. The natural resources of these regions are not only well worth exploiting, but much of the future prosperity of the eastern Sudan will depend upon the measures taken to impound and regulate the headwaters of the Blue Nile, now in Abyssinian territory. Besides, to the south, the most advantageous route for the Cape-to-Cairo railway runs along the border of the Abyssininian highlands, avoiding the swamps of the upper Nile valley.

Italians look upon the political and economic conquest of northern Abyssinia as an essential complement of their Red Sea colony of Eritrea, and in the south their new possession of Jubaland is practically worthless without trade from the productive Abyssinian lands to the north (see the following note).

These circumstances tend to color the policy of all three nations toward Abyssinia, and are well illustrated in their respective attitudes towards the slavery question now before the League of Nations. An impartial discussion of the state of Abyssinia is given by Mr. C.F. Rey in recent articles in the *Geographical Journal* ("Abyssinia and Abyssinians of To-Day," Vol. 60, 1922, pp. 177–194) and *Journal of the African Society* ("Abyssinia of To-Day," Vol. 21, 1921–1922, pp. 279–290, Vol. 22, 1922–1923, pp. 17–29 and 109–120) and in an absorbing book by him entitled "Unconquered Abyssinia as It is Today," Seeley, Service & Co., London, 1923.

The Development of Italian East Africa. As was explained in the foregoing note, the Italian possessions in East Africa must owe their future prosperity in the main to their position as outlets of the trade of Abyssinia and the eastern Sudan. The Italians, however, are making vigorous attempts to promote the local development of these regions so far as limited natural resources will permit.

Of the three possessions, Eritrea, Somaliland, and Jubaland, Eritrea is the most promising. The highlands of Abyssinia are prolonged northward into this colony and give a variety of terrain lacking in the deserts and arid steppes of the southern colonies. Coffee and grains grow in the more elevated valleys, and the hot lowlands of the Barca and Sona Rivers to the west are adapted to cotton. Cotton, indeed, is said to be the outstanding agricultural problem of Eritrea. The Italian government, however, up to the present has not been able to promote its cultivation on an extensive scale. An active campaign carried on a few years ago for the purpose of introducing cotton cultivation in the Barca valley tended to discourage all who were connected with it, capitalists and planters alike. Vigorous propaganda led to widespread planting and a short-lived boom; this was followed by disaster and loss during seasons of drought that came soon after, for no adequate provision had been made for the construction of reclamation works. The Italians now understand that only through extensive governmental co-operation in the building of dams and irrigation canals can anything be expected of their efforts. A great obstacle in the way of carrying through these reclamation projects, however, is the lack of labor. Intense tropical heat renders the region altogether unsuitable for field laborers from Italy. The employment of pilgrims *en route* to and from Mecca and of immigrants from Arabia may partially solve the problem, but a competent critic believes that in the long run nothing tangible can be accomplished without the importation of Chinese. (On cotton growing and other agricultural problems of Eritrea see Orazio Pedrazzi: Centri ed industrie della colonia Eritrea, *Riv. Coloniale*, Vol. 13, 1918, pp.

414–424; Adriano Lanzoni: Escursione nel Marghebla, *Boll. Reale Soc. Geogr. Italiana*, Series 5, Vol. 9, 1920, pp. 249–258; "La mise en valeur de l'Érythrée," *Renseign. Colon.* (*Suppl. à l'Afrique Française*, 1922, pp. 285–288. For a brief but graphic description of Eritrea, see H. Wilberforce-Bell: The Italian Colony of Eritrea, *Journ. Central Asian Soc.* Vol. 10, 1923, pp. 332–340.)

Opinion regarding the construction of railways in Eritrea is divided. One group believes that the present railway should be continued westward to Kassala in the Anglo-Egyptian Sudan not far from the Eritrean frontier (see "L'avenir de l'Érythrée et le port de Massaouah," *L' Afrique Française*, Vol. 33, 1923, pp. 97–98). Massawa, it is argued, is by far the best port on the Red Sea; when the destruction caused by the earthquake of 1921 has been repaired, adequate terminal and transshipment facilities completed, and the railway put through to Kassala, advocates of this plan believe that Massawa ought to become the great outlet for the whole of the eastern Sudan. Others, however, think it would be a serious mistake to try to tap the commerce of the Sudan through Eritrea and that the continuation of the railway to Kassala would result only in draining the commerce of the western part of Eritrea itself out through British territory and northward over a railway which some day will connect Kassala with Port Sudan. They point out that though the actual distance from Kassala to Massawa is less than from Kassala to Port Sudan, the advantages of the former route are more than neutralized by the rugged country it would have to traverse. The route from Kassala to Port Sudan, on the other hand, finds an easy down grade the entire distance. Opponents of the Kassala railway project think, therefore, that the attention of the colonial authorities should be directed exclusively to the building of railways southward to the Abyssinian border and, perhaps, ultimately beyond. They argue that already the trade of Tigre and the Lake Tsana country is finding an outlet by this route and that there are unparalleled opportunities for future commerce when the coffee, ivory, wax, and grains of these remote regions may reach the sea directly by rail. Statistics compiled by M. Boucoiran and cited in the preceding note show that from 1911 to 1917 there was a steady increase in the foreign commerce of Abyssinia by way of Eritrea at the expense of the Jibuti route. (For an argument against the extension of the railway to Kassala see Orazio Pedrazzi: La ferrovia Eritrea ed il suo avvenire, *L'Esplorazione Commerc.*, Vol. 32, 1917, pp. 225–237.)

The entire "horn" of Africa from the base of the Abyssinian highlands eastward and southeastward to the Gulf of Aden and Indian Ocean is a parched and barren country roamed over by nomad tribes. The interior of this tract, which was conquered by Menelik for Abyssinia, is very imperfectly known. Two great rivers, the Juba and Webi Shebeli, rise in the Abyssinian hills and make their way southeastward through Italian territory. The Juba reaches the sea, but the Webi Shebeli, after curving southwest and flowing parallel to the coast for some three hundred miles behind a broad belt of sand dunes, finally disappears in swamps near the mouth of the Juba. An agricultural population clusters about the river valleys, but the greater part of the country is given over to stock raising. (On the population of Italian Somaliland see Giuseppe Caniglia: Note di demografia politica della Somalia Italiana, *Riv. Coloniale*, Vol. 13, 1918, pp. 196–200; Nello Puccioni: Appunti sulla distribuzione geografica delle popolazione della Somalia, *Boll. Reale Soc. Geogr., Italiana*, Series 5, Vol. 8, 1919, pp. 149–159).

The greatest problem in the local development of Italian Somaliland is the problem of water. In the lack of definite knowledge there are wide differences of opinion regarding rainfall and potential supplies of water from subterranean sources (see Romolo Onor: Il problema idraulico del Benadir, *L'Agricoltura Coloniale*, Vol. 15, 1921, Nos. 7 and 8; Giuseppe Stefanini: Il problema idraulico in Somalia, *ibid.*, Vol. 15, 1921, pp. 539–542; *idem*: Il problema idraulico del Benadir, *ibid.*, Vol. 17, 1923, pp. 132–143). Under the able leadership of the Duke of the Abruzzi an extensive work of reclamation is being carried through at Shidli on the Webi Shebeli some sixty miles from Mogdishu. An area of 14,800 acres of agricultural land is to be reclaimed by 1925 by the building of a dam across the river, the construction of a network of irrigation canals, and the clearing of the land, now overgrown with brush and scrub. A third of the reclaimed area is to be devoted to cereals, a third to Egyptian cotton, and a third to forage crops. Communication is maintained with Mogdishu by small steamers on the river and by a light railway over the dunes between the river and the port. (See Giuseppe Scassellati-Sforzolini: I lavori agricoli dell' impresa "S. A. I. S." di S. A. R. il Duca degli Abruzzi nella Somalia Italiana, *L' Agricoltura Coloniale*, Vol. 16, 1922, pp. 89–98; André Devaux: L'Oeuvre du Duc des Abruzzes dans la Somalie Italienne, *Renseign. Colon.* (*Suppl. à l' Afrique Française*), 1923, pp. 181–186.) Now that

Italy has obtained possession of both banks of the Juba it is to be expected that similar operations may be undertaken on that river as well.

From the commercial point of view, Italian Somaliland is situated most disadvantageously. It is separated from the productive central and southern portions of Abyssinia by broad tracts of poor and arid country out of which little trade may be expected to come. More serious is the total lack of a good port. The entire coast from Cape Guardafui to south of the mouth of the Juba is inaccessible from the sea during the southwest monsoon. Kismayu in Jubaland is the first port as you go south that can be used freely at all times of the year.

The Italians had high hopes, therefore, that the acquisition of Jubaland from Great Britain would go far to compensate her for these defects in her colony. According to the secret Treaty of London (1915) Italy's colonial empire was to be enlarged by the cession to it of territory held by Great Britain and France. This was to be done as compensation in the event of the acquisition by Great Britain, France, and Belgium of the German colonies. The greater part of Jubaland, ceded by Great Britain in 1919 and 1920, formed a portion of this compensation (for a map of the new boundary of Jubaland see *L'Afrique Française*, Vol. 33, 1923, p. 266). Jubaland is the continuation west of the Juba River of the dry, semidesert plains that characterize Italian Somaliland. (See the scholarly monograph on the geography of Jubaland based upon a thorough study of the literature of this region by Ruggero Cani: Il Giubaland, *L'Africa Italiana*, Vol. 40, 1921, pp. 137–154 and 177–215.) Except for pasturage and a strip of agricultural land along the Juba it offers little in the way of natural resources. It has, however, a fine port in Kismayu, open to commerce all the year round, a port which the Italians believe is capable of development as an outlet for the trade of the rich districts of southern Abyssinia (much as Massawa is to be developed as an outlet for northern Abyssinia), provided certain trade routes leading thence to the Abyssinian frontier may be placed in Italian territory.

Unfortunately from the Italian point of view, the territory ceded by Great Britain has not given to Italy undivided control over these routes. The western boundary of Italian Jubaland now runs from Dick's Head on the Indian Ocean northwestward to the 41st meridian, thence north along that meridian to Eil Wak, and thence northeastward to the confluence of the rivers Dawa and Juba. Italy's new colony thus tapers off to a point at the north, and the Italian frontage upon Abyssinia has received but a negligible extension by the acquisition of Jubaland. Italian critics feel that Britain's refusal to transfer to them a large block of country along the Abyssinian border to the west of Jubaland has eliminated all possible commercial advantages that might accrue from her possession of Jubaland. The trade of south central Abyssinia will not make its way into Italian territory by way of Dolo at the junction of the Dawa and Juba, for it would first have to traverse an excessively barren and difficult region north of the Dawa. On the other hand Moyale, on the Abyssinian frontier some 210 miles west of Dolo, has been developed through British enterprise as an entrepôt of the commerce from the prosperous districts of Sidamo to the north. A caravan route follows a line of wells southeast from Moyale to Wajhier Dima and thence through Italian Jubaland to Kismayu. The Italians assert that trade will not flow over this route if it has to pass over British soil and in so doing to be subjected to the duties, imposts, and restrictions that such transit would involve. They claim, therefore, that the boundary should be drawn in such a way as to include in the Italian sphere not only Moyale and the trade route thence to Wajhier Dima but also the Lorian swamp to the south, a district of potential agricultural exploitation. They argue that the British will gain nothing by holding Moyale and attempting to attract the Abyssinian trade southward to the Kenya Colony railway. The route through Marsabit traverses desolate deserts, and there seems some justification in the talian contention that, rather than take this route, commodities from Sidamo would tend to find their way northward to Addis Ababa and thence out by the Franco-Abyssinian railway to Jibuti. The Italians, indeed, dream of a rival railway to Moyale and some day to Burji in Abyssinia. Moyale, the goal of their unsatisfied imperialistic ambitions, will perhaps become the key to the understanding of much of the future political geography of this part of Africa.

ASIA

A Proposed New Port for India. A recent paper by Sir George Buchanan on Indian Ports (*The Asiatic Rev.*, July, 1923, pp. 467–477) draws attention to the fact that India with a coast line of 4500 miles, an area of 1,800,000 square miles, and a population of 350,000,000 has only five ports of any magnitude—chiefly because of physical conditions. Karachi and Bombay, both on the west, are seaports proper. Bombay is the main gateway to India,

handling about 40 per cent of the trade (tonnage of goods in 1921–1922). The trade of Madras is considerably inferior to that of the other ports. In spite of the creation of an artificial harbor, the port cannot be used in all weathers. Calcutta and Rangoon are river ports, and considerable expenditures are involved for maintenance of the river service. There is, then, scope for another eastern port if suitable site and situation can be found. Such is claimed for Vizagapatam (India—The Commercial and Economic Situation, *Round Table*, March, 1923, pp. 366–387; reference on p. 380.)

Vizagapatam in the Madras Dependency is roughly midway between Madras and Calcutta. The present port is an open roadstead with the customary dangers of surf. Exports are chiefly manganese, myrobalans (a tanning material), and molasses. There is also a considerable coolie traffic at certain seasons with Rangoon (C. W. E. Cotton: Handbook of Commercial Information for India, Calcutta, 1919). On the prospective development of the port Mr. E. S. Gregg, of the U. S. Department of Commerce, has supplied the following quotations from the *Manchester Guardian Commercial*:

"Its accessibility for Central Indian produce will be at least as great as that of either Bombay or Calcutta, and infinitely greater than that of Madras. It will provide the easiest and shortest route to Burma and the Straits for mails, passengers, or goods. It is already on the railway line, and the completion of the Vizianagram-Raipur branch, which was only partially built when the war put a stop to its construction, will open up direct communication with the Central Provinces and the whole of Central India. . . . .

"The constructional expenses will be very small, as such things go, as comparatively little work is necessary. The programme includes the building of two groins, one at each side of the entrance, the removal of the bar between the groins, the dredging of the backwater, and the construction of the necessary wharves and railway shunts. Stone is available on the spot. The whole scheme is in the hands of the Bengal-Nagpur Railway, which is working with the active co-operation of the Government of India. . . . The new harbour will be ideally protected from storms, and will be in no way inferior to Calcutta in this respect. It remains to consider its comparative accessibility from the sea, and here lies the superiority of the new harbour over Calcutta. Calcutta is one of the most, if not the most, difficult harbours to enter in the whole world. The dangers of the Hooghly are proverbial. The delay caused through its passage even at the best of times, the high piloting charges, and the ever-present danger of the James and Mary and other shoals are a few of its many drawbacks, while bores form at intervals, travel up most of its length, and cause inconvenience to all vessels moored in the vicinity."

The Political and Economic Importance of the North Arabian Desert. Between Syria and Palestine on the west and Mesopotamia on the east there extends a vast barren tract known as the Hammad or North Arabian desert. Separated by the ruddy sands of the Nafud, from the oases of Nejd to the south, the Hammad consists of a calcareous plateau rising to a maximum altitude of some 3300 feet about half way between Baghdad and the Dead Sea. The surface for the most part is nearly level, monotonously uniform, and easily traversed by automobiles, although here and there it is diversified by rough stretches of lava, extinct volcanic cones, or expanses of ground covered with flints and chert nodules. At one place near the heart of the desert the presence of sinter cones suggests the possibility of extinct geysers. Wadi Sirhan, the broad and shallow valley of a dry watercourse, runs in a southeasterly direction toward the northern edge of the Nafud, and a corresponding line of wadis trends off to the northeast toward Karbala and the Euphrates. Near the lower end of Wadi Sirhan but apparently unconnected with it the limestone surface has been worn or dissolved away by atmospheric agencies exposing the underlying sandstones in the deep depression of Juba.

The only permanent settlements in the whole immense area are at Palmyra, at Kaf and Azraq in Wadi Sirhan, and Jauf and Sakaka in the Juba depression. The population of these oases is estimated at some 20,000. "Then in addition there are perhaps about 150,000 Badawin who in the winter and spring, when the rains have watered the desert, graze their flocks on the scanty grass and thorn which have sprung up" but during the summer "leave the desert for the Euphrates valley or the grass lands of the Jordan basin" (A.L.Holt: The Future of the North Arabian Desert, *Geogr. Journ.*, Vol. 62, 1923, p. 263).

In spite of its limited natural resources, this region is of growing importance: politically because of its position in relation to the settled countries adjacent to it; economically because of present and future lines of communication across it.

The North Arabian desert is the hinterland of Syria, Palestine, and Mesopotamia, a hinterland which will probably always contain within itself a potential menace to security in the outlying fringes of these countries. Too spacious and too desolate to be conquered or policed by military force, it is the haunt of wandering, hungry, and predatory tribes and a direct avenue northward for the nomadic warriors who dwell south of the Nafud. Peace and prosperity in the desert-facing frontiers of 'Iraq, Palestine, and Syria depend, therefore, to a large extent upon the relations that are maintained between the British and French administrations and the Arab masters of the Hammad. With a view to investigating the political situation in the Juba hollow, Mr. H. St. J. Philby and Major Holt undertook a journey thither in the spring of 1922. Mr. Philby's account of the journey sheds new light on recent political changes in northern Arabia as a whole (see H. St. J. Philby: Jauf and the North Arabian desert, *Geogr. Journ.*, Vol. 62, 1923, pp. 241-259).

Throughout most of the nineteenth and twentieth centuries central Arabia has been controlled by two dynasties with their capitals at Hail in the Shammar country immediately south of the Nafud, and at Riyadh still farther to the south. During the World War, the Wahhabi Amir of Riyadh, Ibn Sa'ud, who was friendly to the Allies and under whose protection Mr. Philby made the journeys so graphically narrated in his "Heart of Arabia" (reviewed in the *Geogr. Rev.*, Vol. 13, 1923, pp. 484-485), had succeeded in consolidating his power and enlarging his domain. The rulers of Shammar, however, took the pro-German side. A chronic state of hostility which has always existed between the two amirates broke out actively at the time of Mr. Philby's second visit to Nejd, and the campaign was protracted until August, 1921, when Ibn Sa'ud was finally able to administer a crushing defeat to his northern neighbors and to annex the Shammer territory. His conquest, however, was not then extended north of the Nafud and when Mr. Philby and Major Holt visited Jauf in the spring of 1922 the Juba depression and southern Hammad were still maintaining a precarious independence under the misrule of the local family of the Sha'lan. A month later, as Mr. Philby informs us, Ibn Sa'ud's forces occupied Jauf, and in September of the same year Kaf and the Wadi Sirhan was annexed by the Wahhabi chief. As a result of these campaigns the whole interior of Arabia from a point not far from the Dead Sea southward to the borders of the mysterious "Empty Quarter" is now subject to the capable government of Ibn Sa'ud. The miracle of bringing internal peace and tranquility to the heart of Arabia seems to have been accomplished, but whether these benefits will last after the death of their author is another matter.

The geographical position of the North Arabian desert lends it added importance by reason of the lines of communication now existing and to be established across it. An aerial mail service is already in operation between Cairo and Baghdad. Aeroplane landing places have been constructed at regular intervals between Amman and Ramadi, and part of the route has been marked by furrows made with a plow drawn by a motor tractor (see J. J. Lloyd-Williams: Remarking the Air Route from Ramadi to Landing Ground R, *Geogr. Journ.*, Vol. 62, 1923, pp. 350-359). Commercial passenger automobile service has also been established between Damascus and Baghdad enabling the traveler to cross the desert in less than three days and thereby to avoid a long sea voyage (see *The Near East*, Vol. 24, 1923, pp. 455-458). Major Holt, in the paper referred to above which was read before the Royal Geographical Society, is optimistic about the prospects for the construction of a railway across the desert—somewhat unduly optimistic in the opinion of some of those who took part in the discussion of his paper. It is conceded, however, that the engineering problem is not a serious one. Major Holt argues with force that a railway is especially needed in view of the increasing productivity of Mesopotamia under an administration more enlightened than that which the Turks were able to give it. He also believes that a railway from the Mediterranean to Baghdad will be followed by railways penetrating Persia, whose commerce has suffered much through the elimination of the outlet through Russia. Even a certain amount of Indian trade may be expected to find its way through Europe by the proposed route.

WORLD AS A WHOLE AND LARGER PARTS

Indian Migration Within the British Empire. A most critical problem of British imperial administration is that of the Hindu immigrant in the dominions and colonies. As subjects of the British crown the Indians feel that they should be allowed to settle and acquire privileges of full citizenship wherever they wish throughout the Empire. They bitterly resent laws

restricting free migration and measures tending to discriminate against them in favor of Europeans. Not only does this resentment smolder continuously, occasionally bursting into flame, among those who have left India or wish to do so, but it also reacts upon the masses in India itself. And yet there is much to be said for the Canadian, Australasian, and South African point of view. The colonials regard the Hindu settler, with his lower standard of living, his alien religions, and his partiality to polygamy and other Oriental customs, as a menace to the white man's civilization. Though generally conceded that the individual Hindu—hard-working, docile, and fairly intelligent—is not an undesirable immigrant, when one considers the terrific overpopulation of the plainsof Hindustan, their poverty and famines; it is easy to see that a flood of migration of unparalleled magnitude would probably pour forth into the lands of greater opportunity were the barriers once removed.

A careful and impartial study of this subject was published in the September, 1923, number of the *Canadian Historical Review* by Miss Emmaline E. Smillie ("An Historical Survey of Indian Migration Within the Empire," Vol. 4, pp. 217–257). The origins and progress of the Indian migration are here traced, the measures taken to check it explained, and the results of these measures as manifested in anti-British propaganda, strikes, sedition, and "passive resistance" discussed. There are now some three-quarters of a million Indians in the Empire outside of India. From Australasia, Asiatics have been excluded almost altogether, though in recent years a few hundred Hindus and Chinese have been admitted into New Zealand. Indians to the number of 5295 are said to have entered Canada between 1905 and 1916; but it is now estimated that there are no more than 1000 or 1200 in that Dominion. Stringent enforcement of Canadian regulations against their admission, culminating with a dramatic but unsuccessful attempt to land a shipload of these people at Vancouver in 1914, engendered much ill feeling, which, Miss Smillie believes, contributed not a little to recent unrest in India and especially in the North of India. South Africa contains more Indians than any of the other Dominions. They were distributed as follows in 1911: Natal had 135,000; Transvaal, 12,000; Cape of Good Hope, 8000; and Orange Free State, 100. Those in Natal, brought in originally as indentured laborers for work on the plantations, now outnumber the Europeans in that province. Treatment of the Indians has varied in different parts of the Union of South Africa, but nowhere has an adjustment satisfactory to both parties been attained. Most of the earlier activities of Ghandi were devoted to the interests of his compatriots in Africa. Miss Smillie concludes that though "the problem has not yet been solved in South Africa, and the struggle is far from over . . . in general the Indians would seem to be losing their cause in this part of the Empire." Indian immigration is cut off, and "a few thousand have already voluntarily returned home." At present the main center of trouble is the Kenya Colony, where the Asiatic population greatly exceeds the European. Indian leaders argue that in a crown colony like Kenya, if anywhere, their people should be given equal opportunities with the whites, and the Indian Government has supported this doctrine. The local administration, however, has not granted the Hindu colonists the rights and economic privileges which they demand. Geographically the colony is divided into two main regions, an elevated plateau of temperate climate and a low, unhealthy, tropical coastal plain. Though it is the avowed policy of the British element to maintain the upland as a white man's land, even in the coastal plain incidents have occurred which the Indians interpret as demonstrating that their rights to hold property are far from secure.

Other parts of the Empire, such as Mauritius, the Seychelles, the Fiji Islands, Trinidad, and British Guiana, harbor great Indian populations. In densely peopled Mauritius there are no less than 265,000 or over two-thirds of the total population of the island (see *Geogr. Rev.*, Vol. 10, 1920, pp. 416–417). The Indians in these tropical islands present no outstanding racial problems, for these are regions "quite unsuited to permanent homes of a white laboring class." Miss Smillie asserts that here it has only "become a matter of time before the white man will be squeezed out, leaving the Indian in almost complete possession, save for a few white officials, planters, and business men."

A Proposed Atlas of Natural Calamities. The opportunity for geographical research of obviously direct humanitarian value is suggested in a circular letter sent out last June by the Secretary of the International Red Cross Committee, Geneva, to the learned societies of the world. Plans are being perfected for a greater degree of international co-operation than now exists in the preparation for immediate action when the need arises to alleviate the suffering caused by great calamities of nature, such as earthquakes, fires, or famines. Part of this program is a proposed atlas of the world "showing clearly the site and extent

of all great catastrophes, past as well as present, and of such as may reasonably be expected in the future," and the learned societies are asked to interest themselves in encouraging the researches necessary for the preparation and publication of such an atlas.

M. Raoul Montandon, president of the Geographical Society of Geneva, has carried through a preliminary study of this sort which indicates something of the nature of the final, more elaborate work ("À propos du project Ciraolo. Une carte mondiale de distribution géographique des calamités," *Rev. Internatl. de la Croix-Rouge*, 5th Year, 1923, pp. 271-344, Geneva. Also printed separately). M. Montandon discusses the causes, distribution, and destructiveness of the most serious public calamities. To illustrate the type of topic considered, we may refer to the few pages and brief bibliography devoted to "invasions of locusts." Except for the far north and far south, no part of the world is wholly immune from this scourge. The insects appear to breed in particular localities whence they swarm incredible distances. In Europe "it seems that one can distinguish two principal routes of migration, one leading from southern Russia to Prussia and the shores of the Baltic, the other from the mouth of the Danube toward France and Great Britain." Direct and indirect damage by locusts in the United States between 1874 and 1877 is estimated as having caused a loss of no less than $200,000,000.

This interesting paper is accompanied by a series of sketch maps in black and white on Mollweide's equivalent projection, showing the distribution of earthquakes, volcanic eruptions, "tidal" waves, hurricanes, tornadoes, typhoons, droughts, floods, dust storms, conflagrations in cities, invasions of locusts, famines, and the endemic centers of plague, cholera, and yellow fever. Owing to the cost of production a single map in colors representing these distributions was not attempted.

PHYSICAL GEOGRAPHY

The Meteorological Cycle of the Ice Age. Under the title "Die Eiszeit ein meteorologischer Zyklus," V. Paschinger contributes an important discussion to the *Zeitschrift für Gletscherkunde* (Vol. 13, 1923, pp. 29–65).

Among the conditions of glaciation fall of temperature and increase of precipitation are in the first rank, and a common cause must be sought. This may lie in a vertical shifting of climatic belts. It is a known fact that precipitation increases with elevation to a certain height which differs according to climate and season; and that the belt of maximum precipitation has important recognized effects upon the hydrography and morphology of elevated regions. In applying this principle it is necessary to make a distinction between the zone of greatest rainfall and the zone of greatest snowfall, since these two forms of precipitation influence glaciation in quite different ways. In the Alps the heaviest rainfall occurs at elevations of 1500 to 2000 meters (approximately 5000 to 6500 feet), and the greatest snowfall at an elevation of 2500 meters. The elevation of the belt of maximum precipitation is largely determined by local conditions not by latitude. It is not a fixed but rather a movable belt and lies much lower during periods of persistently low temperature. If by a drop in temperature the lower limit of snow sinks to the belt of heaviest precipitation a snow cover is formed from which there is little melting. The temperature fall at the end of the Tertiary had such an effect upon the position of the snow cover, pulling it down into the zone of maximum precipitation, vastly increasing the snowy accumulations, and bringing about the Pleistocene glaciations.

The meteorological conditions of glaciation—cooling at the poles and in middle latitudes and rise of the temperature between the tropic circles and over the seas down to the 60th parallels of latitude—may be met by a small inclination of the ecliptic during a favorable eccentricity. According to Paschinger the process of cooling originated at the poles and may have proceeded as repeated cold waves. The polar air cooled by strong radiation blew out in anticyclonic fashion, passing under the warm air currents from the west and pushing them up. Cold waves, followed by rapid condensation, proceeded down towards middle latitudes. The result of the primary cooling was a thicker and more extensive snow cover. Snow melting in summer caused a further fall of temperature on account of the change of sensible heat into a latent form. As soon as the lower edge of the snow cover had moved down into the zone of greatest snowfall the main part of the snowfall was no longer melted away, the areas of nourishment increased, and glaciers finally filled the mountain valleys. In the Alps, where the belt of heaviest snowfall would lie 500 meters (about 1600 feet) below the lower limit of the snow cover, a permanent depression of the summer temperature of 3° C. (5° F.)

would be sufficient to inaugurate the conditions of the last glaciation. In Paschinger's view the pluvial periods in the Mediterranean region, the Great Basin, and other regions distal to the ice were synchronous with the successive glaciations.

Diminution of the snow and ice cover could only follow upon decreased nourishment, which in its turn may have been due to the effects of a permanent glacial anticyclone which proceeded to desiccate the ice after it had reached a very large extension. It is concluded that the expansion of the first ice sheet may have been checked largely by topographical obstacles. The ice border finally reached a position where its complete melting could take place through the effects of heat from the ground and of heat received by reflection, and by direct insolation. Once the snow line began to rise it would continue its upward retreat with increasing rate; for there would be less and less area of snow-covered surface, and the principle of self-stimulation would come into play. If the ice had less thickness in the central than in its peripheral parts, this too would hasten the rate of retreat.

The end of the glacial period was characterized by drought, rise of temperature, and rise of the zone of maximum precipitation. Later, with a return of the conditions of refrigeration, the precipitation increased, and the snow limit moved downwards, inaugurating a new expansion of the ice. This second glaciation may generally be less than the first one, because the original region of glaciation has undergone glacial denudation, and the secondary cooling due to altitude becomes less powerful. By repeated denudation of the mountains that serve as gathering grounds of the ice the favoring conditions of glaciation disappeared altogether. The cycle was closed when the zone of heaviest precipitation had withdrawn to the high mountain ridges and the primary cooling did not develop a permanent snow cover. The relatively small extension of the first glaciation, which according to the hypothesis should be the largest, may be due to topographical obstacles. The necessity of assuming such topographical obstacles seems to be a weak point in the theory. *A primary rise in temperature appears as necessary to explain the disappearance of the ice as is a fall to explain the glaciation.* And the chronological studies of the ice retreat leave little doubt that a rise of temperature was the primary factor. The origin of such high temperatures is not understood by the reviewer.

According to Paschinger's hypothesis, mountains in an oceanic position would become glaciated at an earlier period than mountains lying far within the continents, and glaciation would be of shorter duration in lower mountains than in higher ones. Paschinger finds support for this view in the observations of different authors, particularly in those of the monoglacialist, E. Geinitz, who says that the Pleistocene deposits of different regions are not synchronous; that the Ice Age, so-called, was essentially a local phenomenon; and that the expressions glacial, interglacial, etc., *do not mean age but local periods of time.*

To the above abstract of Paschinger's able treatise a few remarks may be added. Although the rate of ice recession from Fenno-Scandinavia and New England, where it is best known, on the whole gradually increased as the retreat went on, yet there were many and considerable fluctuations which are not accounted for by Paschinger's theory. The fact that boulders were transported by the North European ice sheets from near the center of glaciation down to the outermost moraines in central Europe shows that the ice sheet, whatever its condition in the retreatal stage may have been, really was thickest at the center for a long time and that considerable nourishment occurred here in spite of the "glacial anticyclone." Except for the fact that the precipitation decreased, these conditions prevailed up to the last stage of the ice cover; for then the center lay over quite low land east of the Scandinavian mountain range, and the westward flow was uphill.

It may also be doubted whether evaporation was greater during glaciation than at normal times. Since the growth of the successive ice sheets required that precipitation over the glaciated areas should be heavier than at present, it almost certainly was less in non-glaciated regions. Since it seems probable that during the ice retreat the summer temperature was high and the precipitation slight or even very slight over the ice itself and in the surrounding belts, the pluvial period in the regions far distant from the glaciated areas may have been synchronous with the ice retreat rather than the ice advance.

Ernst Antevs

GEOGRAPHICAL REVIEWS

The Capital City: a Step in its Interpretation

Vaughan Cornish. **The Great Capitals: An Historical Geography.** xii and 296 pp.; maps, index. Methuen & Co., Ltd., London; George H. Doran Co., New York, [1922,] 9 x 5½ inches.

The new point of view and the new method of treatment are always productive of arresting work. Dr. Cornish presents a book that just falls short of being a monograph. He endeavors to prove that great capitals occupy strategically forward sites with reference to empire and positions within the empire which lie in natural storehouses, at dominant crossroads, or at places which are natural strongholds. The position may have any combination of these advantages; but the forward site is believed to be characteristic, while the stronghold is of least relative importance. So much is explained in the preface. The book takes up the review of the great capitals of Eurasia, the United States, and the Inca Empire, from the earliest times to the present day. Each capital is presented as an illustration of the thesis, so that the reader sees the proof, as the author says in his preface, not in the argument but in history. The book is hard reading, and to read it intelligently a reference atlas is indispensable; one would also like to have at hand a series of historical volumes, for the author assumes that his audience has the necessary background of historical knowledge. But it is fascinating reading. If the task seems formidable let the reader turn first to the "easy" sections on the capitals of Holland and Denmark. They will create an appetite for the whole book.

The Great Capital is not explicitly defined, but we take it to be the directive center of the state that establishes power. Dr. Cornish undoubtedly proves his argument for the period of active operations which lead up to the consolidation of empire. His method of thought throughout, consistent with some of his previous contributions to geography, is that of a campaigning strategist. The capital is General Headquarters, and its functions are to conduct conquest and to maintain consolidated power. G. H. Q. keeps up with the advance and occupies positions that either provide it directly with means of subsistence or enable it to get them with comparative ease. When empire is established, G. H. Q. confronts the most important neighbor of questionable behavior. The regularity with which the author produces capital after capital fulfilling exactly these requirements is astonishing.

We feel, however, that the argument is incomplete. The world seems to have entered a new phase of occupation, involving a fixation of established foundations. The great cities of Europe and the colonial foundations overseas, be they capitals or not, are communities of baffling complexity and have established relative stability of status. The Great War *displaced* no capital in spite of the wholesale dismemberment in central Europe. Vienna and Budapest are going to live. The only capitals seriously affected are Petrograd and Prague. The former, an artificial foundation, is assuming natural proportions, and its fall can hardly be said to have added much to the ancient prestige of Moscow. Dr. Cornish approaches a realization of the deeply buried and almost intangible geographical causes which underlie the existence of cities—capital or other—in his uncertainty about Saxon London and modern Madrid.

London was not used as a capital in Saxon times. Dr. Cornish is at a loss to account for its historical eclipse and the fact that it "never surrendered unconditionally to the Saxon tribes." In his discussion of London, however, his interest centers on the minor considerations of the site rather than the major ones of its position. Little though we know of the town at this time, it seems that London was alive and well, with a mind of its own, and strong enough to stand beside the principalities of the time as an equal, as the author hints. But the geographical foundation of this strength is not studied. Madrid also is regarded as an anomaly. It is suggested, first, that the capital would be better placed in the forward maritime position of Seville and, again, that the decadence of Spain may be due to the failure to place it there. Seville as the capital of Spain would resemble Athens, but the maintenance of Athens has not prevented the decay of Greece. The Spaniards have preferred Madrid for over three and a half centuries, but the author does not investigate their reasons.

If the simple principle advanced holds true for all capitals, we should expect to be able to trace its influence on the capitals of the Balkan states during the twentieth century wars. Sofia is the only Balkan capital receiving more than mention; Athens (surely a great capital), Oporto, Brussels, Prague, Cracow, and Helsingfors too receive inadequate treatment or none at all: yet a very clear account is given of the early Scottish capitals in the district of Perth.

Dr. Cornish is prone to refer to the immediate region of the capital as the "metropolitan" region. Herein lies confusion. The metropolis is not necessarily the capital. Antwerp, Hamburg, and Liverpool are metropolitan (economic) units but are not capitals. In the United States indeed, with the exception of Boston, the Twin Cities, and possibly Atlanta, no metropolis has even the honor of being a state capital.

"The Isothermal Frontier of Ancient Cities," dealt with at some length in the volume, seems to us to require rigorous test before acceptance. The evidence produced is attractive, but it is impossible, as yet, to say what influences are diagnostic in city geography. When a large number of varied quantitative data have been collected and analyzed, the diagnostic influences (if they exist) for particular grades of cities may appear. The map of the apparent isothermal frontier is brilliant and tempting, but it is the application of a selected condition rather than the revelation of order. One would like to know, for example, if the cities on the isotherm were comparable in population. When the author applies the principle to the Inca Empire, the test of three examples (one of them a modern city) is quite inadequate. Little is known of the density distribution of the ruling race. Though the Incas were builders they were not great city builders and assumptions based on their extension of empire involve subject peoples and a wide range of conditions.

The references, for a work of such scope, are few and not the ones the unlearned in history would wish for. No reference is made to any modern contributions to human geography or its branch of city geography. There is a regrettable absence of maps and a fairly liberal number of typographical errors. The seventeen page index is admirable.

Altogether, the work is suggestive and stimulating and should take its place as a standard of reference on a limited phase of city geography. It is a style of treatment unusual in the English language. Should a second edition be forthcoming, we hope to see the principle applied to the Caliphates and Egypt; indeed to the whole of Africa, to the British Dominions, and exhaustively to Europe.

The British in Tropical Africa

F. D. Lugard. **The Dual Mandate in British Tropical Africa.** xxi and 643 pp.; index. William Blackwood and Sons, Edinburgh and London, 1922. 8½ x 5½ inches.

Written with a wealth of experience gained as High Commissioner and Commander in Chief of Northern Nigeria (1900–1906) and as Governor General of Nigeria (1914–1919) and with years of previous service in Nyasaland, East Africa, and Uganda, this volume is invaluable not merely as an account of the development of Nigeria but also because of its sane and practical counsels for the future, applicable to colonial administration throughout tropical Africa. Its several chapters deal with the acquisition of the British African tropics and with their status and conditions, the principles governing control in the tropics and their populations, general principles of administration and its machinery, the British staffs, the home government and the dependencies, methods of ruling native races, taxation, land tenure and transfer, slavery, labor, education, transport, trade, economic development, law and courts of justice, the problems of self-government, armed forces, missions, and intoxicants, and the value of British rule in the tropics to British democracy and to the native races.

The student of geography, particularly in its economic aspects, can scarcely fail to read Sir Frederick's work, for, although one "may regard the future of Africa for some decades to come as chiefly concerned with the development of her agricultural, pastoral, and mineral resources" (p. 510), the possibilities of her growth must not be left wholly out of account. (These matters are fully discussed in G. L. Beer's "African Questions at the Paris Peace Conference," reviewed below.) Climatically, however, and contrary to early expectations tropical Africa has proved, for the most part, uncolonizable by Europeans, though much may be accomplished by close attention to housing, water supply, physical exercise, and medical service.

Three chapters call for special attention in the present connection: the two on economic development and that on transport. Even now deforestation is a real problem; but, though systematic irrigation as practiced in Asia is little known in Africa, considerable areas are capable of reclamation. Nevertheless, Africa is becoming increasingly desiccated, and the desert is constantly encroaching on the cultivated lands, a phenomenon which, taken in conjunction with the same process in Central Asia, is of ominous portent for both continents.

Sir Frederick devotes a number of pages to outputs already established in Africa, particularly palm oil and palm kernels, cotton, and cocoa; but he also observes that these tropics "afford a vast and fascinating field for experiment in the acclimatization of new products, with a view to broadening the basis of industry, and for the improvement of those products which are indigenous." Here come fodder grasses, sisal, ramie, piassaba, jute, flax, maize, bananas, pineapples, ginger, limes, tobacco, sunflower oil, castor oil, kola, gummiferous trees, teak, mangoes, cattle, goats, sheep, swine, ostrich feathers, honey, and fish, with other products within the range of possibilities.

The chapter on transport is based on the premise that "the development of the African continent is impossible without railways." Carriage by porters, at present the only method available throughout wide areas, costs, at a daily wage of ninepence, about three shillings per ton mile, whereas "one railway train of average capacity and engine power will do the work of 13,000 carriers at one-twentieth the cost." So great is the need of transportation that "in constructing a pioneer line in Africa, the one and only object should be to get the track through somehow and begin to earn receipts," postponing the construction of stations, large bridges, and the like; but, on the other hand, providing only the highest quality of rails, steel sleepers, and rolling stock. The best system of building in Africa, where railways "have in all cases proved to be abundantly remunerative," is by the local government, which should own and maintain them; and the central workshops should be built inland, both for safety in time of war and to escape the physical and moral dangers of the coastal regions.

Throughout the book the author lays stress on the development of tropical Africa in the interests of the natives as well as of the colonizing Powers; and his essential position is that "the civilized nations have at last recognized that while on the one hand the abounding wealth of the tropical regions of the earth must be developed and used for the benefit of mankind, on the other hand an obligation rests on the controlling Power not only to safeguard the material rights of the natives, but to promote their moral and educational progress" (p. 18).

Louis H. Gray

Concerning the Political Geography of Africa

G. L. Beer. **African Questions at the Paris Peace Conference, With Papers on Egypt, Mesopotamia, and the Colonial Settlement.** Edit. by L. H. Gray. xliv and 628 pp.; maps, diagrs., bibliogr., index. The Macmillan Co., New York, 1923. 9 x 6 inches.

In a geographical treatment of the great frontier zones of civilization account must surely be taken of the conditions of political ownership and policy. Without such adjunct data the study becomes narrow, unreal, and indeed sterile; for no longer do the great currents of emigration and commerce run full and uncontrolled but rather constricted and diverted by many artificial obstructions. It is in this sense that Beer's book on African questions is a contribution of interest to geographers. The historical and political foundations of African colonial life are skillfully traced, and the account is all the more useful for being plainly told. The style is direct and clear; the problems are dispassionately set forth; the judgment of the author is admirable as it plays over a wide range of topics and conditions. In a sense the book is a memorial to the author, whose death followed not long after his return from the Peace Conference of Paris. The text is edited by L. H. Gray, who has also supplied valuable footnotes and annexes and brought the statistical information down to date, besides writing a preface and a long and useful introduction. The body of the book consists of a detailed statement of the colonization, resources, management, and bearing of the German colonies in Africa; the economic aspects of the problem of Central Africa; and problems of international co-operation and control in Central Africa. Condensed historical and economic accounts of Egypt and Mesopotamia are given. The book concludes with four chapters on colonial questions in tropical Africa, former German Southwest Africa, North Africa, and the Pacific Islands. A unity is given the whole work by the mature and scholarly interest

of the author in colonial questions, despite the dissimilarity of the regions which he treats. The material was first prepared in 1917–1918 at the house of the American Geographical Society as part of the program of the well-known Commission of Inquiry working under the auspices of the Department of State.

CHARLES LUCAS. **The Partition and Colonization of Africa.** 228 pp.; map, bibliogr., index. Oxford University Press American Branch, New York, 1922. $4.20. 9 x 6 inches.

Our indebtedness to Sir Charles Lucas for his historical geographies of the British colonies is increased by this admirable introduction to the political geography of Africa. A series of lectures given before the Royal Colonial Institute in 1921, it is no systematic treatise but "designedly somewhat discursive, with the intention of suggesting diverse points of view and a variety of subjects for further study in one direction or another." Throughout, however, there is a unifying thought—the significance of European intervention in Africa.

Africa is preëminently the dependent continent, in the main a great dependency of Europe. The first three chapters—on the history of Africa to the nineteenth century and the slave trade—deal with conditions that culminated in this state of affairs. There is a reminder, however, that we are not concerned solely with European aggression and penetration into a passive continent. The African races have pressed upon one another. For instance the majority of the South African natives are comparatively recent immigrants there. Again, the Arab invasion was one of the most profoundly important events in the history of the continent. It made northern Africa "not so much the southern fringe of Europe as the western end of Asia." Mohammedanism was one of the two great human agencies that helped to keep Africa the "dark continent." The other was the slave trade, distinction being made here between the trade of the west coast with its economic basis and the Arab trade of the east coast primarily domestic in character. Suppression of the slave trade, both east and west, was a strong stimulus to exploration of the interior (Ch. 4) which in turn influenced the "Scramble for Africa" by the European nations (Chs. 5 and 6).

In following chapters is given a brief regional treatment of political problems on the basis of the classification into colonies of population and settlement and colonies of exploitation—an expression used by Jules Cambon when Governor of Algeria. North Africa pertains to both categories, predominantly the latter; South Africa to the former; and East and West Africa are definitely spheres of exploitation (with minor exceptions such as parts of Kenya). A chapter on the war in Africa leads to its consequences on the political map and on the problems now confronting the European nations concerned. Sir Charles' own views are expressed in the final paragraph, here quoted:

"If we consider the African races, or at any rate the negro and Bantu races, whether in Africa or in America, their outstanding features are, on the one hand their strength and vitality, and on the other their ability to do without European guidance. What has Hayti or even Liberia made of self-government? The right view of Africa and the Africans is not to regret that Europeans came in, but to deplore that, having come in, they were guilty of so many abuses instead of shouldering their rightful job, which is to be trustees of the black men until in some distant future (if ever) the black men have become able to stand by themselves."

The appendixes include useful explanations of the status of certain political arrangements and a note on books.

GEORGES HARDY. **Vue générale de l'histoire d'Afrique.** xx and 200 pp.; map, bibliogr. Armand Colin, Paris, 1922. 5 fr. 7 x 4½ inches.

It would be a great advantage to American scholarship if books like this one were as readily available here as in Europe. In two hundred pages of admirably organized text that can be purchased for about thirty-five cents the author supplies a handbook of Africa that is eminently practical. It is more than an introduction to the subject, for it has the two high qualities of maturity of judgment and a spirit of fairness in dealing with the policies of other powers. There is an opening sketch of the state of Africa before the coming of Islam, followed by a more detailed account of the Islamic movement, its handicaps and successes, especially in the eleventh century, together with an account of the growth of indigenous empires. The longest chapter (Ch. 3) deals with European exploration in Africa, the territorial division of the continent, and the effect of European ownership and exploitation upon native life. Most suggestive of all is the final chapter which deals with the development of a

sense of solidarity, if not nationality, among regional groups of Africans, as in the case of blacks turned Mohammedan and among the north Africans who live closer to exciting forces of European origin. A developing sense of nationality and of rights to national land, the examples of Liberia and Abyssinia, the revolts in Egypt, South Africa, and West Africa are brought into the story. There is a concluding section which deals with European rights, influences, and opportunities today not only in their effect upon Europe but also in their effect upon the African native.

Britain as a Colonizing Power

Albert Demangeon. **L'Empire britannique: Étude de géographie coloniale.** viii and 280 pp.; bibliogr. Librairie Armand Colin, Paris, 1923. 7 fr. 7½ x 5 inches.

This work is a brilliant essay on Great Britain as a colonizing power. Each chapter marches straight forward, after the French style, toward clear objectives. There are three parts: the formation of the British Empire, colonization and civilization, and imperial problems. The first part is historical; but it is not merely a chronological skeleton, it is a swiftly moving account of the workings of that colonizing genius which has made the English great. The genius consists not alone in controlling the sea and keeping it free, nor in sending out vast capital on uncertain as well as certain trading ventures, but to a larger degree in the willingness of successive generations to go out to the colonies either to settle or to trade and govern. In spite of a powerful mercantile system England never forgot that a mercantile system alone could not keep together peoples so diverse and so widely distributed geographically. It is the power of accommodating itself to the local or regional needs that keeps the Empire intact. A fusion of its ethnic elements is impossible; and military and naval power are not a reliable political element, important as they are, in safeguarding seaborne commerce and protecting weak and distant strategic frontiers. Though the treatment is brief throughout, it is exceedingly well-balanced; and the documentation is admirable in view of the compactness of the discussion—there are but 264 pages of text. There is a particularly discriminating choice of subjects and data in the treatment of the outlying parts of the Empire, notably Canada, Australia, South Africa, and India.

A History of United States Boundaries

E. M. Douglas. **Boundaries, Areas, Geographic Centers and Altitudes of the United States and the Several States, With a Brief Record of Important Changes in Their Territory.** 234 pp.; maps, diagr., ills., index. *U. S. Geol. Survey Bull. 689*, Washington, D. C. 1923. 9 x 6 inches.

This is the fourth edition of a highly important work of reference containing geographical material presented nowhere else in so convenient a form. The text is illustrated with very clear outline maps, or cartograms, that analyze the historical changes in territory associated with our state and national boundaries. There are, in addition, a map showing the routes of the principal explorers in the territory of the United States, a copy of the Mitchell map of the United States (1755), and a copy of part of J. Disturnell's map of Mexico published in New York in 1847. Among other illustrations there are a number of photographs showing the various types of boundary monuments in use. Not the least important service rendered by the book is to supply an inventory of United States possessions. For example, there is a description of the seven so-called "guano islands" occupied or claimed under the Act of Congress of 1856 whereby otherwise unoccupied guano islands are "considered as appertaining to the United States" if occupied by one of our citizens. They are all in Caribbean waters except Gente Hermosa in the Pacific. Besides these there is an unsettled question as to American reserved rights in the case of Christmas Island (lat. 1° 57′ N., long. 157° 28′ W.). There are described the changes in the Panama Canal Zone boundary whereby the original five-mile limit was exceeded to take in the shores of Gatun Lake; the purchase of the Cagayan Sulu and Sibutu groups of islands north of Borneo because of the error in drawing the limits of the Philippines in the treaty of 1898; and the status of the Wrangell Island question and of the islands of the Tonga group besides Yap, Wake Island, and others. Many states have had boundary questions of moment, and their settlement has in some instances given rise to curious boundary features not all of which are correctly represented upon current maps. "The Gore" in northeastern Vermont is an irregular tongue of land about a mile wide

which is often shown as a part of New Hampshire. It was as late as 1881 when the much-disputed boundary between Connecticut and New York was finally settled by an agreement approved by the Congress of the United States. Oklahoma and Texas are still disputing the position of their boundary on the eastern border of the Panhandle of Texas; and, although a decision by the Supreme Court of the United States has been handed down in the case of the Red River boundary between these two states, a future decree by that court will be necessary to settle the differences that have arisen between the boundary commissioners.

Legal Status of Aborigines

A. H. Snow. **The Question of Aborigines in the Law and Practice of Nations.** v and 376 pp.; indexes. G. P. Putnam's Sons, New York and London, 1921. $3. 9 x 6 inches.

This volume, originally written for the United States Department of State in 1918, is concerned solely with the status of "members of uncivilized tribes which inhabit a region at the time a civilized state extends its sovereignty over the region, and which have so inhabited from time immemorial; and also the uncivilized descendants of such persons dwelling in the region." After an historical introduction from the Anglo-French Treaty of 1763, the author considers such problems as aborigines as wards of the state and its powers over them (United States, Great Britain, France, the Netherlands, Belgium, Italy, Spain, Portugal, Japan, and Germany); personal and land rights of aborigines; duties of states as guardians and agreements between them or their nationals and aboriginal tribes; effects of the foundation of the Congo Free State and of the establishment of the Conventional Basin of the Congo; international action since the Berlin Congress of 1885; effect of the doctrine of "intervention for humanity" upon the development of the law of nations as regards aborigines; and the "triple principle" applied in Morocco. The work is simply a compilation, with no deductions or recommendations; and no attempt has been made to bring it up to date since it was first written, though such a study as, for instance, Louis Vignon's "Un programme de politique coloniale: Les questions indigènes" (Paris, 1919) might have been consulted to some advantage.

Louis H. Gray

A New Interpretation of Economic Evolution

N. S. B. Gras. **An Introduction to Economic History.** xxiv and 350 pp.; maps, diagrs., ills., bibliogrs., index. (Harper's Historical Series.) Harper & Bros., New York and London, 1922. 8 x 5½ inches.

Mr. Gras has written a book for beginners to explain how human society has developed the management of its important affairs. It is a small book from which definitions, the enunciation of scientific laws, and the use of statistics are practically absent. Nevertheless it gives in its six chapters a lucid account of the evolution of economic systems. The presentation is novel, suggestive, and stimulating.

Human society passes through stages in economic development. A group of people occupying a certain territory works out a method of utilizing available resources, which is perfected to a degree corresponding with the civilization of the group. Doubtless the advance of civilization and the improvement of economic method react on each other, an advance in knowledge permitting an improvement in economy which in turn provides the necessary freedom for a further advance of civilization. Five stages of economy have been developed in the course of history, each more complex than the preceding one, each marking a level of efficient management for the corresponding stage of civilization, and each capable of lasting for a long time—so long that it may lag behind civilization and become inefficient. Different groups at different times have passed through successive stages of economy, and there may have been periods in history when the highest existing stage was lower than that obtained by vanished groups of the more distant past. All five stages exist in the world today. The stage is not stationary, and the process of transition from one stage to another is gradual, though perhaps of shorter duration than the life of the stage itself. The history of a group shows that some element of the system exhibits a mutation, slight but of great significance. It caters to a great need, solves growing difficulties of management, and within a relatively short period a new thing is in existence—economy has moved to a higher stage. Viewed from the present, the change looks rapid, and its origin seems vague. Historical re-

search finds the indications to have existed in the old order, sometimes almost indiscernible and difficult of direct proof; but history is developing the technique of interpretation by co-ordinating its diverse data, so that the real conditions of the past are being more and more faithfully realized. The remoter the period, the greater is the use of inference and analogy; but here, too, anthropology and archeology have valuable material to offer.

Mr. Gras considers the following stages to be the important levels of economic attainment.

1. Collectional Economy
2. Cultural Nomadic Economy
3. Settled Village Economy
    - Phase 1. The Free Village
    - Phase 2. The Dependent Village
4. Town Economy
    - a. The Earlier Town (Commercial)
    - b. The Later Town (Commercial and Industrial)
5. Metropolitan Economy
    - Phase 1. Organizing the Market
    - Phase 2. Industrial Development
    - Phase 3. Transportation Development
    - Phase 4. Financial Organization

Collective economy is the primitive stage of collecting the needs of the group directly from the regional sources. Storage of commodities for times of hardship and division of occupation according to the natural abilities of the sexes are perhaps the outstanding features of management. Under the system a large area will support only a relatively small population.

Cultural nomadic economy appeared when man became a herder and a gardener. Division of labor became more pronounced, gardening falling to the women. Superiority of advantages raised some groups, as the mounted nomads, to a high level, the combined results of rapid movement and conflict leading to riches, the institution of a slave class, surplus production, and trade. Storage of commodities attained a higher position than before.

Settled village economy was the next stage. Growth of population is regarded as the cause of settlement of nomadic groups on fertile areas, where agriculture was easy. The village, a closely knit group, was generally an organized stronghold but came also to be a territorial area. Slowly the development of plant and animal culture went on, the making of implements, and the perfection of an efficient method of stationary occupation of the land, until in Europe the exigencies of pasture and soil fertility produced the two and three field systems.

The independent village, with its slave class, was liable to conquest by unsettled wanderers and thus often lost its freedom to a conquering lord; unconquered villages organized for defense by the system of "commendations of person and lands" to qualified leaders and organizers, who eventually came to occupy a position not very different from that of actual conquerors. Thus, in one way or another, the village lost its independence and drifted into feudalism, an institution evolved in many lands at different periods. The interests of the lord probably did much to raise the level of agriculture and crafts, and the opportunity for storage of goods led to high results. In the statement "All villages provided most of the things needed: none provided all" (p. 81) Gras reveals the germ of later economic growth. The market day and the market village became established, and the trade relation assumed a definite direction.

According to orthodox economics the village, even as late as the thirteenth century in England, was such an *eingeschlossene Einheit*, with its elaborate code, partition of duties, and suspicion of strangers, that the rise of occasional outstanding communities is difficult to understand. They did arise in favored places, as military and administrative centers with unusual market facilities. Their economy was strictly that of the village; but on them, in the later phases, town economy was grafted.

Town economy followed next. Growth of the village market eventually produced the specialized trader. Whence and how he came we do not know. Traders established themselves in the outstanding villages, and economy took a vast step forward. Trade became organized, and larger economic units of many villages and one town arose. The radius of the unit and the size of the nucleus increased, and a more complicated and more efficient

system replaced village economy. The extended scope of internuclear relations made for greater opportunity, prosperity, and comfort. Individuality found some expression, and the fusion of village groups grew into units numerically strong.

In its first phase the town developed trade into commerce. Later it captured manufacture from the villages step by step, increasing the variety of occupation and the complexity of government. Added strength came as feudal control was fought off or bought off, and great power was developed by the town leagues. Town economy, attaining its richest development since ancient times in Lombardy and Flanders, remained the high level of economy until the nineteenth century.

Then came metropolitan economy. The town attained its success, but a few towns attained many successes—in commerce, industry, politics, and art. Their later development promised something far beyond town economy. They were able to reduce their neighbors to satellitic economic subordination, rising to metropolitan rank while their former peers remained towns. The outstanding town became a metropolis by assuming a new and grander function—that of organizing business for a wide metropolitan area (*hinterland*). Marked advantages of situation enabled the town to establish this commercial dominance over the area. Once again there is a welding of units to form a larger unit, with a greater nucleus and increased intricacy of organization. Gras devotes two long chapters to the metropolis. In one he considers mainly England and presents his conception of metropolitan development. In the other he considers America and the metropolitan trend.

The town had encountered the difficulty of insuring a steady supply of staple foodstuffs for the compact agglomeration and early in its life had adopted measures which solved the problem. The rising metropolis found great difficulty of adjustment and only after long struggle, experiment, and loss was it able to obtain and store a regulated supply of grain.

In its first phase the metropolis substituted specialized wholesaling and exchange for the markets of town commerce; developed the machinery of hinterland trade, storage, and extended trade; and initiated changes and improvements of transportation within the metropolitan radius. During this phase there was evident, in Europe, a conflict between the mercantile national policies and the metropolitan trend towards open trade.

Industrial revolution marked the second phase of metropolitan growth, wholesale handicraft being converted to centralized industry. Factory production inevitably centered in the metropolis at first but gradually migrated to the hinterland, leading to further improvement in road and canal construction.

Revolution in transportation of goods and ideas, by land and sea, by train and telegraph, consolidated the metropolitan unit and brought it into keen rivalry with its peers. The marches of the hinterlands became vigorously contested until their final capture by one or the other metropolis; and a few towns became ambitious of metropolitan rank. Particularly in America, some towns, such as Cleveland, have entered the arena, carved out a hinterland, and established themselves without passing through the earlier phases, finding, as it were, ready-made conditions on which to graft a metropolitan growth.

The increasing specialization and fluidity of trade, with its system of bills of exchange, the growing importance of stock exchanges, and the perfection of elastic banking organization mobilized to perfection all the resources of the unit and led to the present-day culmination of metropolitan economy, the financial phase.

Throughout the book Gras deals with a group of people with common interests, occupying a particular territory. This is the economic cell. It develops a nucleus and proceeds to enlarge itself by the fusion of walls, aggrandizement of the nucleus, extension of the periphery, and increasing complication of its tissue. The group is never divorced from its region, nor is the nucleus treated as an entity. It is merely a point of concentration of regional activity. The metropolis deals with the world on behalf of the hinterland and is hence only expressible in terms of the hinterland. Gras handles the stupendous material of economics in the spirit of advanced geography and is able to present a clear conception of interacting things and processes which cannot be bounded by definitions. He does not say just what a metropolis really is but is content to state a number of metropolitan criteria. He lays down no rules for mapping the hinterland boundary but uses the Federal Reserve districts as a somewhat arbitrary indication of the metropolitan range of influence in the United States, with the Twin Cities as a special example.

In sum we may state that a conception of economic history has been presented which harmonizes well with contemporary geographic thought and which promises a very helpful liaison for the interpretation of modern problems.

Economic Reports on the Russian Far East

—— **Dokladi Primorskoi Okruzhnoi Torgovo-promishlennoi Palati po Voprosam Ekonomiki Russkago Dalnyago Vostoka, predstavlennie na Vashingtonskuyu Konferentsyu 1921 goda.** [Reports of the Maritime District Trade and Industrial Chamber for Economic Questions of the Russian Far East, presented to the Washington Conference, 1921.] v and 459 pp.; map. Maritime District Trade and Industrial Chamber, Vladivostok, 1922. 10½ x 7½ inches.

V. E. Glusdovsky. **Primorsko-Amurskaya Okraina i Syevernaya Manchzhurya.** [The Maritime Amur Region of Russia and North Manchuria.] 2nd edit. ii and 183 pp.; maps, ills., diagrs. Vladivostok, [1917]. 10½ x 7 inches.

The first title refers to a set of reports drawn up with the purpose of influencing the Washington Conference to procure the liberation of the Russian Far East from Japanese occupation and of attracting the favorable attention of foreign governments and business interests to the region. The information given is rather narrowly confined to what might further these ends and is sharply summarized under each subject in the form of "theses." Economic conditions and opportunities, naturally, are given most space. Only two pages (14–15) are devoted to strictly geographical description—a few general facts culled from *Asiatic Russia* (Aziatskaya Rossiya), published by the Colonization Bureau in 1914. The "thesis" based upon these is: "The Russian Far East, besides being Russian territory by virtue of right, is also organically bound up with Russia. This organic bond arises from the fact that Russia is a continental power, whose coast line, with the exception of the Far East, has no outlet except into closed or frozen seas. Under these circumstances, the Amur region, with its seacoast and ports affording an outlet to the open sea, necessarily becomes vitally and organically an indispensable part of Russia" (p. 20). This is in some ways a better statement of the case than that which concludes the pamphlet by V. E. Glusdovsky issued by the Vladivostok Chamber of Commerce in 1917. For description of the country, however, there is no comparison between this document and that interesting and valuable publication.

J. V. Fuller

The Development of Hydro-Electric Energy

Henri Cavaillès. **La houille blanche.** vi and 216 pp.; maps, diagrs., ills. *Collection Armand Colin (Section de Géographie) No. 23.* Paris, 1922. 5 frs. 6½ x 4½ inches.

The development of hydro-electric energy is to a very large extent governed by conditions of physical geography, and the utilization of the energy when generated modifies the facts of economic geography to a varying degree (compare the article, "The Geographical Conditions of Water Power Development" by Raoul Blanchard, pp. 88–100 of this *Review*). For these reasons there is much satisfaction in reviewing a book on water power by a writer who possesses a clear understanding of the meaning of geography. This small book is written for the general reader. It is in no sense an engineering manual. Nevertheless the opening chapters form as good an introduction to the subject as the reviewer has seen. They comprise in fifty-two pages a clear and concise account of the more general aspects—physical conditions favoring power development and thus limiting it to certain regions of the earth; the works required for the regularization of flow and for the production and distribution of energy; the various uses to which the energy from different types of river can be most economically applied.

The most valuable feature of this work, however, is the admirable presentation of the present status of water power development in France, a section occupying over half the book. Readers of recent French periodical literature have had opportunities to learn of the various hydro-electric projects in France, but here for the first time we have a conspectus of the whole national activity in this direction. Americans are apt quite naturally to think of their own country as the scene of mushroom growth in industry, and the facts here presented regarding old France may well cause them some surprise. Before the World War France had harnessed her "white coal" to the extent of about 900,000 horse power. This was less than the total for Italy, and it was derived almost entirely from the Alps. But the war gave tremendous impetus to development. France, bereft of most of her coal supply, turned feverishly to her rivers, and in doing so she not only proceeded to meet rapidly much of the demand for munitions of war but at the same time laid the foundations of an entirely new

industrialism in the central and southern parts of her territory. Thus in striving to win the war she was able to further her permanent economic aims of peace time in a degree probably much greater than was the case in any other country engaged in the war. By the end of 1921 France had approximately doubled her pre-war developed horse power, so that she then stood behind only the United States and Canada in this respect. When horse power and population are compared, France is found to stand fifth, with 4.7 h.p. per 100 inhabitants—approximately equal to the United States (the first four countries being Norway, Canada, Sweden, and Switzerland). It has been estimated that France possesses about ten million potential horse power, so that by 1921 she had scarcely developed one fifth of this. But the projects are large, and the prospects of immediate development in many cases are good.

The water power of France is here treated regionally and in so excellent a manner that "La houille blanche" must be regarded as an essential document for those occupied with the geography of that country. The four "power" regions in order of importance are as follows: (1) Alps, Rhone, and Jura; (2) Pyrenees; (3) Central Massif; (4) Rhine, Vosges, Moselle, etc. In each of these regions all the aspects, physical and economic, are treated; and the significance of the change brought about in the life of the region is indicated in each case. Of the projects discussed, the two greatest are those of the French Rhone and the Rhine about Strasbourg. Both schemes involve not only the production of energy but also the improvement of navigation, while in the case of the Rhone there is to be an increased amount of water available for irrigation on the left bank. The last section of the book treats briefly the hydro-electric development in Spain, Italy, Switzerland, Scandinavia, Canada, and the United States.

Alan G. Ogilvie

The World's Forests

Raphael Zon and W. N. Sparhawk. **Forest Resources of the World.** With a foreword by Gifford Pinchot. Vol. 1: xiv and 493 pp.; maps, diagrs., bibliogrs.; Vol. 2: pp. vii and 495–997; maps, bibliogrs., index. McGraw-Hill Book Co., New York, 1923. $12.00. 9½ x 6 inches.

This monumental work, prepared under the authority of the Secretary of Agriculture and in co-operation with the National Research Council, presents the results of several years' labor by these two economists of the U. S. Forest Service, assisted by a corps of research workers. It is of as great interest to geographers as to economists and may be esteemed one of the outstanding achievements of the past few years in economic geography.

The sixteen maps, in colors, are a notable contribution to our knowledge of the native vegetation and the climatic conditions in various parts of the world, as well as the character of the forest. The impressive fact which grows on the reader as he looks over these maps is the small extent of the forests outside of eastern North America, northern Europe and Asia, and the Amazon and Congo basins. Most of the world is grassland and desert. The forest area of the world is estimated at 7487 million acres, which is about 22 per cent of the total land area. Probably one-quarter to one-third of this "forest" land is sub-humid woodland and chaparral, or burned-over areas not restocking. It is interesting to note that in the British Isles, which were mostly covered with forest originally, only about four per cent of the land is now in forest.

A list of the maps suggests the broad scope of the studies: I, Forest Regions of the World; II, Forests of Southern and Western Europe; III, Forests of Norway, Sweden, and Finland; IV, Actual and Potential Forest Lands of the British Isles; V, Forests of European and Asiatic Russia; VI, Forests of Asia Minor, Persia, and Afghanistan; VII, Forests of China; VIII, Forests of Southern Asia and the East Indies; IX, Forests of Japan; X, Forest Regions of Canada and Newfoundland; XI, Forests of the United States; XII, Forests of Alaska; XIII, Forests of Mexico, Central America, and the West Indies; XIV, Forests of South America; XV, Forests of Africa; XVI, Forests of Australia and Oceania.

The statistical tables thickly scattered through the text (numbering 432 in all) are probably of even greater usefulness than the maps. Some of the tables, however, quote figures that are a little old and for that reason may be misleading; but doubtless more recent data are unavailable. Frequently the date of the statistics given in a table of statistical statement is omitted. It would be helpful to students and worth the additional space if the sources of data given in the tables were given in footnotes. Space could be saved by cross reference to the bibliography given at the end of each section.

The value of these tables as well as the general character of the work may be illustrated by the description of the forest resources of Argentina. Under the heading "Extent and Distribution of Forests" it is noted that the forest land "amounts to 264,012,000 acres, which is 36.1 per cent of the land surface and 32 acres per inhabitant." A table follows giving the forest area by provinces and the percentage forested, also a few words of geographic comment. Under the next heading "Character of Forests" a description, occupying several pages, is given of the five principal forest regions. Statistics are provided of the area, the total stand, and the merchantable stand of several important woods. The next subject treated is the "Ownership of Forests." The treatment includes a table of the area of state forests. "Annual Growth and Annual Losses" is the next subject discussed, which is followed by a description with accompanying table of the "Annual Cut." Several pages are then devoted to the "Timber Trade," including a table of annual exports of quebracho logs and extract, 1893 to 1920. It appears that exports to Germany have slowly decreased, and those to the United States rapidly increased in importance. The imports of wood into Argentina exceed the exports. According to a table the United States is the principal source of supply of lumber, whereas Europe furnishes most of the wood veneer, boxes, and wood pulp. In the discussion of "Domestic Consumption" it is interesting to note that of the 111,135 houses in Buenos Aires in 1909 only 4 per cent were of wooden construction. The next subject discussed is "The Lumber and Wood-Using Industries." This section includes a table of wood-using plants in Argentina—their number, the number of employees, and the capital invested. "Forestry Movement and Legislation" is then considered; and there follow a few paragraphs on "Secondary Forest Products" and "The Probable Future" of the forest resources and the industry. Several pages are then devoted to a description of the characteristics and uses of some 54 different and important woods, and the section on Argentina is closed by a list of 25 books, reports, and articles.

Practically all the countries of the world are treated in a similar way. It is obvious that such summaries of the forest situation and trade in forest products are of great value not only to teachers of economic geography but also to commercial concerns engaged in foreign trade and, perhaps not least important, to students of forest policy. The United States has been favored above all countries of the world in the extent and character of its forest resources. But only about 16 per cent of the virgin forest remains; and the day is rapidly approaching when second-growth timber, mostly of poorer quality, is practically the only kind that will be available. It is none too soon, therefore, to survey the forest resources of the world with a view to finding a source of future supplies of lumber and other forest products. The prospect is not reassuring.

O. E. Baker

Climatic Handicaps of American Agriculture

Franz Termer. **Wetterschäden und Landwirtschaft in den Vereinigten Staaten von Amerika.** 79 pp.; bibliogr., index. (Studien über Amerika und Spanien, No. 1.) Max Niemayer, Halle a. Saale, 1923. 9 x 6½ inches.

Dr. Franz Termer, Privatdozent at the University of Würzburg, has written a useful and interesting discussion of the unfavorable features of the climates of the United States from the viewpoint of agriculture. So far as we can recall, no previous publication has attempted to cover the same ground. The author states that his chief reason for writing his monograph was the practical motive of giving useful information to those of his fellow-countrymen who, because of the economic conditions in their own country, may be compelled to seek new homes in the United States. He desires to supply them with such information concerning the "outs" of our climates as may enable them to be better prepared to meet and to guard against these unfavorable features.

The introduction summarizes some of the more recent investigations in the field of agricultural meteorology and climatology. The difficulties in the way of trying to reduce the many complex relations between weather and climate on the one hand and the character and yield of the crops on the other are pointed out. There is a very natural tendency to attempt to reduce such relations to simple terms, but when we are dealing with the complex resultant of many variables, simple formulae, however much they may appeal to us, are often unsafe and unsound. There is a brief but on the whole well-considered and vivid description of the climates of the United States. To an American with some knowledge of the climates of his own country it may seem as if some rather essential matters had been

omitted, and there are a few somewhat inaccurate, or perhaps rather misleading statements; but on the whole the account is distinctly good. The climatic phenomena injurious to crops are classified under temperature (cold waves, frost, hot waves); precipitation (amounts and types of rainfall, droughts, floods, hail, thunderstorms); and wind (northers, chinook, tornadoes). Consideration of individual phenomena is followed by discussion of their geographical distribution by climatic districts. In this are included Valgren's data relating to the average annual damage to the staple crops, given in percentages of the normal yield in the ten-year period 1909–1918. These data are somewhat rearranged by Dr. Termer and are classified by geographical or climatic districts. At the end, under each staple crop, the phenomena most likely to injure the yield are listed in the order of their importance. Thus, e. g., under corn the list is as follows: 1, Drought; 2, Excessive moisture; 3, Frost; 4, Hot winds; 5, Floods; 6, Storms; 7, Hail; 8, Other unfavorable weather conditions.

R. DeC. Ward

Indian Rainfall and South American Weather

R. C. Mossman. **On Indian Monsoon Rainfall in Relation to South American Weather 1875–1914.** *Memoirs Indian Meteorol. Depart.*, Vol. 23, Part VI, pp. 157–242. Calcutta, 1923. 12 x 9¼ inches.

This paper may be considered a continuation of those studies of meteorological relations between widely separated parts of the earth which have occupied Mr. Mossman for many years. In beginning he discusses the accuracy of the data used and says that, "As far as possible only material of undoubted accuracy has been used, and in cases where values previously published differed from those kindly sent by the Directors of the South American Weather Services the anomalies have been investigated and cleared up, either by correspondence or from the original records, as published at the time." This care in selecting and testing data is characteristic of Mossman and makes the tables of data published by him of unusual value. There is one exception in this paper, however, where he uses in his investigations some data published by Bigelow and it may be questioned whether these data were tested by usually accepted methods.

Mossman first takes up the seasonal distribution of rainfall in South America and finds that only at Punta Arenas, in the extreme south of the continent, and at three stations in the province of Buenos Aires is there an approximately even distribution of the amount of precipitation throughout the year. "In Chile, except in the far south, and more especially north of latitude 40° S. there is a distinct winter maximum. In Argentina, with the exceptions named, the data refer to places with a summer maximum, and this also applies to Ascunción (Paraguay), Sucre (Bolivia) and to the Brazilian stations south of Rio. In the latitude of Recife, 8° S., a winter maximum is again shown, while further north in the state of Ceará, represented by Forteleza and Quixeramobim, practically all the rain falls in the first half of the year." In Argentina the summer maximum is confined to the region north of about latitude 32° S. In the province of Buenos Aires and in the Pampa there is, in general, an autumn maximum, and in the region of Neuquen there is a winter maximum. Returning to the extreme north of South America, "In the Guianas there is an autumn maximum and a pronounced minimum in spring, using the seasons in their southern hemisphere sense. At Trinidad June to September are wet, and February to April dry months."

The first step in his investigation of the relation of South American weather to that of other regions was in regard to the high pressure center near the central coast of Chile and the low pressure center near Graham's Land on the edge of the Antarctic continent. He says that from an earlier investigation . . . "it would appear that there is a well pronounced seesaw of pressure between the South Pacific high on the one hand and the Antarctic low situated to the west of Graham's Land on the other, and that the changes in the pressure gradient between the two systems explain many of the variations in South American weather south of the tropics, particularly on the coast of Chile in middle latitudes, and in the adjacent Argentine territories. When we look into the matter more closely, however, we do not find during the eleven years under consideration the expected simplicity that the comparison of Antarctic conditions to the west of Graham's Land and those on the coast of Chile in the years 1904 and 1909 would lead us to expect . . . The changes in the general circulation so far as these are shown by the prevailing winds indicate that the 'action centers' of the whole globe must have been subject to extreme changes in these two years 1904 and

1909, since the *mean* wind direction at many places in both hemispheres changed through more than a right angle between the two years."

He also compares the pressure on the Chilean coast with the monsoon rainfall and finds an agreement in sign in nine years out of eleven. A seesaw of pressure between the Chilean coast and India has been found by a number of different investigators, and there can be no doubt of a close relation between the pressures in the two regions.

Mr. Mossman next compares the rainfall along the northern coast of Chile with that along the southern coast and finds a distinct tendency toward opposition. When the rainfall is above normal in southern Chile it is likely to be below in northern Chile and vice-versa. The cause of this is probably the north and south movement of the center of high pressure in the Pacific under the influence of variations of solar radiation.

Finally the ice conditions at the South Orkneys are compared with the rainfall of India. The ice conditions are classified by seasons into "open" and "close." "With regard to seasons characterized as 'open ice,' in some cases the seas were ice-free except for occasional streams of loose pack, but the conditions summarized refer to the general conditions surrounding the South Orkneys as observed every day from an elevated point and not to the periods during which Scotia Bay was ice-bound." A close relation is found between the ice conditions around the South Orkneys and the rainfall of northern Chile and central Argentina, the rainfall being in excess in summer and autumn when the ice conditions were open and in defect when they were close. The opposite relations were found in winter. Less marked correlations were found for other parts of South America. The author remarks that, "It is, of course, probable that the conditions determining the varying characteristics of seasonal rainfall in extra-tropical South America are not necessarily due to ice, and that the general circulation that determines the excess or deficiency of rainfall may similarly affect the ice conditions." These changes in the general circulation are considered by the present writer to be due to changes in the intensity of solar radiation. No conclusive correlation was found by Mossman between the ice conditions in the South Orkneys and the monsoon rainfall of India.

H. H. Clayton

Antillean Earthquakes

Stephen Taber. **The Seismic Belt in the Greater Antilles.** Map. *Bull. Seismol. Soc. of Amer.*, Vol. 12, 1922, pp. 199–219.

The tremendous relief of the rock surface in the Antillean region has always excited interest. Spencer thought the deep troughs were valleys eroded when the land stood at a much higher level than now. Vaughan recognized the presence of fault troughs. Taber has gone further. In a paper on "Jamaica Earthquakes and the Bartlett Trough" (*Bull. Seismol. Soc. of Amer.*, Vol. 10, 1920, pp. 55–89) he showed that the most probable place of origin of many Jamaica earthquakes, notably the great earthquakes of 1692 and 1907, was north of the island on the southern edge of the Bartlett Trough and not near the southern side of the island, as has been generally held. In "The Great Fault Troughs of the Antilles" (*Journn. of Geol.*, Vol. 30, 1922, pp. 97–98) and in the paper under review he has brought strong physiographic and seismological arguments to bear to show that trough faulting is responsible for the great and characteristic relief of this region and that the movements are still in full activity. He has located, as far as possible, the origins of many great Antillean earthquakes and has shown that they lie on the sides of the troughs; therefore the sides of the troughs are fault zones, and the troughs themselves are fault troughs. This brings out another important idea, namely that in future the great earthquakes of the region will originate in these zones, either where they are submarine or where they cross the land, and will not be located haphazard over the region.

We note a few more of Taber's results: Milne and Montessus de Ballore have concluded that earthquakes occur chiefly on steep slopes. Taber shows that the reverse is not always true but that great submarine slopes may persist long after active movement ceases; for example the very steep slope north of St. Croix and the northern boundary of the Caribbean Sea seem to have been free of great earthquakes in historical times. Severe earthquakes in the Antillean belt have been caused by vertical displacements, though they have rarely, if ever, been accompanied by a sudden change in the elevation of the coast line. The movements have been due to vertical forces; they cannot be ascribed to surface loading or erosion but must be due to changes in density. The sea waves accompanying submarine shocks in

the Antilles have always, so far as known, advanced with the trough leading, emphasizing the downward rather than the upward fling on the sides of the fault. Further study may, I think, modify this deduction. The paper is of much interest to students of earthquakes and earth relief and is in harmony with geologic investigations recently made by others in the Antillean Islands.

HARRY FIELDING REID

SOME RECENT PAPERS ON MAN AND THE ICE AGE

———**Man and the Ice Age.** *Nature*, No. 2766, Vol. 110, 1922, November 4, pp. 617–618.

H. J. E. PEAKE. **The Ice Age and Man.** *Man*, Vol. 22, 1922, pp. 6–11.

C. E. P. BROOKS. **The Ice Age and Man: A Note on [the preceding article].** With a Note by J. E. Marr. *Man*, Vol. 22, 1922, pp. 75–76.

L. S. PALMER. **The Ice Age and Man in Hampshire.** Diagr. *Man*, Vol. 22, 1922, pp. 106–110.

M. C. BURKITT. **Notes on the Chronology of the Ice Age.** *Man*, Vol. 22, 1922, pp. 179–182.

H. F. OSBORN AND C. A. REEDS. **Old and New Standards of Pleistocene Division in Relation to the Prehistory of Man in Europe.** Maps, ills. diagrs. bibliogr. *Bull. Geol. Soc. of America*, Vol. 33, 1922, No. 3, pp. 411–490.

A good reference note in *Nature* for November 4, 1922, gives in a concise form a report on the important discussion which took place at the Hull meeting of the British Association by the sections on Anthropology, Geology, and Geography on the subject of the relation of man to the various subdivisions of the Ice Age in Britain. No definite agreement was reached, nevertheless the discussion was most useful and will further stimulate the production of work along the lines of several papers recently published in *Man*.

The first of these papers noted here is by H. J. E. Peake who introduces the question thus: "The divergent opinions held by geologists on the question of the Ice Age and the various views advanced by archaeologists on the relations subsisting between the glaciations and the first phases of human activity, have long hindered a clear understanding of the early days of man. During the last year or two these differences have been tending to disappear, and it is perhaps worth while for one, who has hitherto kept free from all controversies on this subject, to put forward tentatively a scheme which may, perhaps with subsequent modifications, meet the views of the varying schools of thought. The scheme is only in outline, and is confined to the evidence in British, Baltic and Alpine regions; for other areas have been equated satisfactorily with one or other of these." Following Penck and Brückner, European geologists generally look on the Ice Age as having presented four separate stages of glaciation—the Günz, Mindel, Riss, and Würm; with three interglacial periods—the Günz-Mindel, Mindel-Riss, and Riss-Würm; whilst the post-Würm period is one of gradually diminishing oscillations, merging finally with historic times. In England, on the other hand, "opinion in official geological circles favors the monoglacial theory, based mainly on the view that there is no evidence here for an oscillation in temperature," though a polyglacial theory has also supporters. The author leans to the opinion that "the Mindel and the Günz of Penck are the two maxima of the first glaciation." He then presents his own geological scheme for England and Scotland, correlating it with conditions in Scandinavia and a part of France and with cultural manifestations. The scheme on the whole appears to be a very reasonable one. The early paleolithic cultures, from the Pre-Chellean to Early Mousterian, are placed in the Riss-Würm interglacial period, the middle Mousterian in the Würm, the late Mousterian to Azilian with the post-Würm oscillations. But there are two serious features in the scheme which are not justified by the author. The one is the placing of those parts of the Ice Age that preceded the Riss—hence fully one-half, if not over, of the glacial time—into the Pliocene. The second, relatively insignificant and yet seemingly scarcely more justified, feature is the inclusion of the Foxhall flints in the scheme at the bottom of the scale, at a vast distance from even the Pre-Chellean. The advance of the Pliocene to, if not beyond, the middle of the glacial epoch could only be sustained by the most weighty and convincing facts; while the inclusion of the Foxhall remains when, notwithstanding all that has been written about them, their time value is still uncertain, serves no good purpose, unless it is thus graphically to show the meaning of the claims for these specimens. The author and his

colleagues would earn a very grateful acknowledgement from less favorably situated students by a thorough critical exposé, and if possible a definite settlement, of the whole Foxhall question.

Mr. C. E. P. Brooks, as a geologist, partly supports, partly tends to correct Peake's classification of the Quaternary English deposits. The Chalky Boulder Clay, which Peake regards as Würmian, he considers to be Mindelian or belonging to the Mindel-Riss interglacial period. He agrees with Peake in throwing doubt on the validity of the Günz-Mindel interglacial: "I should like to go further and divide the whole Ice Age into two glaciations only, the Günz-Mindel and the Riss-Würm, both composed of several oscillations and readvances. Recent work by Scandinavian geologists suggests that over the greater part of Norway and Sweden the ice only completely melted away once during the whole glacial period, but then for a very long interval. After the Rissian readvance there is no return of a really temperate fauna until the close of the Ice Age."

To the above J. E. Marr adds two paragraphs, with the first of which (the second concerns a more local problem) many students of the question will fully agree. They are: "The views of the relationship of the different stages of Palaeolithic times are so varied and conflicting that nothing short of a full discussion of the problem is of much use. Even at present, some hold that Palaeolithic man dwelt in this country in pre-glacial times, others that he is entirely post-glacial [?], others, again, that some of the Palaeolithic stages belong to an interglacial period. There is a tendency for the upholders of the different views to pay scant attention to the arguments of their opponents. The ideas of those who adopt the third position above mentioned seem to be gaining ground, but the writer feels that much more information must be obtained before the question can be considered as being finally settled."

In a well written account, Dr. Palmer outlines the geological and archeological conditions of the Hampshire basin and gives a sensible tentative graphic outline of the "geology-culture correlations" in this region. He shows the connection of the Acheulean and Chellean cultures with the Riss (and possibly Mindel-Riss), the Mousterian with the Würm and post-Würm, the Aurignacian with the Bühl, and the Magdalenian with the post-Bühl climatic period or subdivision of the Ice Age (the Bühl and post-Bühl periods being smaller oscillations manifested in the last or post-Würm ice recession). As to the "Mousterian and post-Mousterian cultures, the foregoing conclusions are in close agreement with those of Peake and also with a chronological table recently published by Burkitt, and thus they agree with the equation by which Mousterian man is coupled with the Würm ice epoch."

"Notes on the Chronology of the Ice Age," by Miles C. Burkitt, is, regrettably, but a glance at the subject, but a glance that for its soberness and precision calls for a grateful acknowledgment by the students of the question. If one thing above all is needed in this important and difficult field, it is a thoroughly sane as well as modernly scientific treatment, which will brush off the accumulated cobwebs and bring us into close touch with plain realities. The author, who has only recently given us his valuable "Prehistory" (Cambridge, 1921) and who is evidently more directly acquainted with the bulk of the field of early man in Europe than any other recent writer, brings forth evidence that (1) "A part, at any rate, of the Lower Palaeolithic is post-Riss. The relative chronology of the archaeological divisions in France shows us a Chellean with a warm fauna underlying an Acheulean with a cooler fauna. It is logical, therefore, to add to the above conclusion that in the warmest times between the Riss and the Würm the Chellean culture was flourishing and was followed, as the cold of the Würmian glaciation began to be felt, by the Acheulean, which appears to be only a development of the Chellean. (2) A Würmian date must be assigned to the Mousterian. Whether the cultures flourished just before, during, or just after remains a problem. The writer believes that the Mousterian straddled across Würmian times and that in some localities it will be found just before, in some during, and in others just after. (3) The Magdalenian culture is post-Würmian, and, from the above considerations, must be assigned to the Bühl epoch." (4) In England, most of the "Upper Palaeolithic industries appear, as far as has yet been discovered, to be Aurignacian in various stages of development." With the researches of Reid Moir on "Tertiary Man" the author is "not here concerned."

The appearance in short succession of the serious contributions to this subject by Brooks, Burkitt, Marr, Palmer, and Peake is a welcome sign of a renewal of true scientific interest in questions which will possibly prove easier of solution in England than on the continent and which will have no small effect on the much-needed clearing of the still present mists in France, Belgium, and other parts of western and central Europe.

A synthesis of the problem is given by Henry Fairfield Osborn and Chester A. Reeds in "Old and New Standards of Pleistocene Division in Relation to the Prehistory of Man in Europe." In submitting this work for a review the authors state that "This Synthesis does not claim original observation by the authors in Europe in either of the nine branches of science which it attempts to synthesize. The observations and theories of acknowledged leaders in each of these nine branches are co-ordinated as accurately as possible from their writings, and in several cases through their own personal revision of our MSS and text . . . This Synthesis seems to us to establish the four-glacial theory on a relatively firm basis; yet it still leaves unexplained the fact that only during the final or Fourth Glaciation was there a real refrigeration of western Europe north of Lat. 43°. The First Glaciation sent its refrigeration only as far south as Lat. 53°."

The undertaking is without question a most praiseworthy one and, owing to the nature of the subject, must have proved a difficult piece of work. The authors "have attempted to set forth as accurately as possible the views of the thirty-seven authors chiefly quoted"; with the main object that "this Synthesis may lead to renewed and *synthetic research*, through which alone can these discrepancies be understood." These authors include Antevs, Barrois, Bishop, Boule, Brooks, Brückner, Chamberlin, Chaput, Commont, Croll, Daly, De Geer, De Lamothe, Depéret, Gagel, Geikie, Gignoux, Harmer, Huntington, Leverett, Mayet, Montelius, Obermaier, Osborn, Penck, Pissot, De Puydt, Sauramo, Schuchert, Soergel, Suess, Taylor, Van Barn, Vayson, H. Virchow, Wahnschaffe, and Wright. The "synopsis and partial synthesis" is supplemented by a "Review and Critique of the Penck-Brückner, De Geer, Depéret Systems," by Leverett, Alden, de Martonne, Johnson, and Davis; and the volume is illustrated by numerous charts and figures, supplemented by five pages of bibliography.

There is little to be added to the above, except a few words as to the part by Osborn and Reeds themselves (pp. 470–472). Facing page 470 we find a chart by these two authors giving their present views on "Correlation of Marine, Terrace, Climatic, Racial, Culture, and Life Stages." This chart is not easy to digest, and there seems justified a call for simplification; but otherwise it leaves little to be desired. It marks a decided advance over a similar chart by the same authors published in Osborn's well-known "Men of the Old Stone Age." So far as human remains are concerned, the only somewhat serious objection that may be made is to the unqualified placing of the Foxhall remains in the Pliocene, at an immense distance from the "Early Chellean." Opinion concerning the exact nature and age of these remains has not as yet become definitely crystallized, even in England. But this is rather a minor point in comparison with the value of the whole work and the bringing together of hardly accessible data published in various languages, for which all students of the subjects involved will be grateful.

A. Hrdlička

Scandinavian Cultures

H. F. Osborn. **Our Ancestors Arrive in Scandinavia.** Map, ills. *Natural History*, Vol. 22, 1922, pp. 117–134.

This is a popular, attractive and nicely illustrated article, "the fourth in the series on early man in Europe," dealing on the basis of the researches of De Geer and Montelius with man's occupation of Scandinavia and the cultures he passed through in that territory. Curiously, no mention is made of the Lapps or old Finns, who probably played a not unimportant part in the original settlement of the peninsula. The chronological table of cultures for Scandinavia is now probably more definite and more nearly correct than that of any other European country. According to this, man reached the southern coasts of the country during the latter part of the Old Stone Age, or about 11,000 B. C. Montelius believed these reindeer hunters were the (much abused) Crô-Magnons, which opinion Professor Osborn seems to accept (p. 121) but rejects later: "There is no evidence of the occurrence of the broad-cheeked Crô-Magnon type of late Palaeolithic Age in the oldest Scandinavian graves" (p. 127).

A. Hrdlička

Gunnar Ekholm. **De arkeologisk-etnologiska problemen iOstersjoomradet.** [The Archeological-Ethnological Problems in the Baltic Region.] *Ymer*, Vol. 43, 1923, pp. 51–80.

The paper is an attempt to give a survey of the present archeological knowledge of the

countries around the Baltic Sea and treats the subject from purely archeological, ethnological, and philological viewpoints.

The time of the first appearance of man in Scandinavia is not known. The oldest living sites in Zealand (Maglemose, Sværdborg Mose) belong to a rather late part of Ancylus time, but *pics* of reindeer horn and flint points of Nørre-Lyngby type are considerably older. During Ancylus time man spread to the northern parts of Sweden and Norway, although evidences of intensive settlement date first from Litorina time. (Cf. H. F. Osborn: Our Ancestors Arrive in Scandinavia, reviewed above.) The old theory of the Asiatic origin of the Indo-Europeans is now generally abandoned; their cradle must surely have been in northern and central Europe.

The people taking possession of the Scandinavian peninsula after its release from the ice had from the beginning a culture largely uniform. From this stock, probably from the beginning comprising different elements, the several Nordic tribes have differentiated in the course of time. The original home of the Nordics was not merely southern Scandinavia but the whole Scandinavian peninsula, northern Germany down to the central German mountain ranges, and the coast regions east of the Baltic Sea. Peoples of other origin now living on the shores of the Baltic are relatively late immigrants. The Baltic was a *mare Germanicum* already during the stone age.

The cultural center of the Indo-European ancestors of the Nordics during the whole Stone Age and Bronze Age was located in Denmark.

Ernst Antevs

The Climate of Brazil

Boletim de Normaes: Observações meteorologicas feitas no ex-Observatorio Nacional, hoje Instituto Central, do Rio de Janeiro, e nas Estações da rêde Nacional. viii and 66 pp. Minist. da Agric. Indust. e Commerc., Direct. de Meteorol., [Rio de Janeiro], 1922. 12½ x 9½ inches.

The scope and purpose of this bulletin—the first comprehensive weather report of the Brazilian government (a copy was received by the reviewer in June, 1922)—are so well set forth by Dr. Sampaio Ferraz, the director of the new meteorological service, that it is worth while to give here a full quotation:

"The first and principal care of the Section of Climatology of the new Bureau of Meteorology, created in May of this year [1921], has been to prepare for publication the observations collected by the old Bureau of Meteorology and Astronomy, established in November, 1909, whose first and only Bulletin of 1910 was published in 1914. However, before attending to the printing of the vast sum of data, corresponding to the years 1911 to 1920, we decided to publish immediately the normal values of the existing series.

"This is the work that we now present to the public. Of course its value is entirely relative, not only because it includes the first efforts of a very new net, whose observations suffer the faults and defects inherent in an inexperienced personnel, but also because the total number of years of the various series presented is much too small, and the periods different. As to the last, however, it must be noted that in certain regions the range of normals varies within small limits, so that the values obtained in a short space of time will diverge little from those deduced from longer periods. At any rate we believe that they will not fail to render interesting the results of this bulletin, especially when it is borne in mind that they are the first of the character of normals to be published, thus permitting an insight into some aspects of the climate of Brazil."

The Introduction is a discussion of the methods and instruments employed and the possibility of error in certain series of observations. The next 22 pages are taken up with tables of data for Rio de Janeiro. These are by far the most complete of all in the report and cover a longer period of observation—39 years—than those of any other station. Every phase of climate is considered: means and extremes of temperature and rainfall for each day and month of the year; means of accumulated precipitation day by day from the beginning of the year; mean monthly and annual atmospheric pressure; monthly and annual means of means and extremes of temperature; monthly and annual means of tension of vapor, relative humidity, nebulosity, direction and velocity of wind, rainfall and days of rain, evaporation, insolation, clear days, cloudy days, thunder and lightning, and fog.

Then follows a large table showing the geographic position, altitude above sea level, position of instruments, and date of foundation of the ninety other stations of the "national net." Incidentally this table is probably the most reliable source of information extant on

the geographic positions of the places named. And it is interesting to note that one observatory is situated at 2280 meters above the sea, well towards the summit of Mt. Itatiaya which was long considered Brazil's highest mountain. Fortunate it was for the reviewer that the government chose this location, for in 1922, while engaged in an ornithological survey of the Serra do Itatiaya, I found the house of the observer in charge of this station the only shelter available in that bleak region. During my weeks under that hospitable roof I watched with admiration the care and punctuality of the observer—a native woman—and I feel constrained to say that if the data gathered at the other stations throughout Brazil are of the same quality as hers, Dr. Ferraz might well omit his reference to an inexperienced personnel. No storm was ever too severe, no night too black, no wind too cold to prevent the observer from making her observations at the prescribed hour.

The remaining 41 pages of Dr. Ferraz's report contain the climatological tables for all the stations of Brazil other than Rio de Janeiro. Of course they are not so full nor so detailed as the tables for the capital, but they include data on temperature, rainfall, atmospheric pressure, wind, etc., and in no case is the period of observation less than five years.

It is interesting to find from a study of these tables that the hottest normal recorded for all Brazil is that of Quixeramobim, Ceará, a town in the arid region, latitude 5° 16′ S., where the average annual mean is only 81.5° F. and in twenty-four years the mercury has not risen above 99.2° nor dropped below 64.2°. (For the convenience of my readers I have converted all temperatures and rainfalls here quoted, from the Centigrade and millimeter readings given in the original report, to Fahrenheit and inches. I do this in spite of my conviction that the use of the Fahrenheit scale and the English system of measurement should long ago have been abandoned.) Turyassú, not 2° south of the equator on the coast of Maranhão, has a normal of only 78.8° and extremes of 99.7° and 59.2°. The figures for Manáos, nearly a thousand miles up the Amazon and only a little over 3° south of the equator in the center of the largest and perhaps the densest forest in all the world, are 81°, 101.5°, and 66.2.° Astonishing as it may seem, the relative humidity is only 78.5° per cent—about the same as that of Rio de Janeiro or New Orleans.

Further study of the data presented demonstrates, as would be expected, that the same rule which applies to temperature range in the northern hemisphere is also operative in the southern—that is that the difference between the maxima and minima increases with the the distance from the equator. Passing southward from Manáos to Rio de Janeiro, a city barely within the tropics, we find a normal of 72.7° F. but a range of 51.8°. Proceeding thence to the temperate zone (so-called) we find at Sant'Anna do Livramento, latitude 30° 53′ S. in Rio Grande do Sul, a normal of only 63° while the range between the absolute maximum of 104.9° and the absolute minimum of 23° is 81.9°—the greatest of all stations in Brazil. But even this is 13.5° less than the range at New Orleans, which is about 60 miles nearer the equator.

The highest maximum for all Brazil, 107.6° F., was recorded hardly more than a hundred miles away at Uruguayana in the same state. The lowest minimum for the entire country is 20.5°, recorded near the summit of Mt. Itatiaya already mentioned, where also were recorded the lowest normal, 52°, and the lowest maximum, 73.6°.

The matter of rainfall will not be gone into here at length, for it is discussed by Professor Jefferson in the article "New Rainfall Maps of Brazil" on pages 127–135 of this number of the *Geographical Review*, though passing reference may be made to the irregularity in areal distribution. A remarkable instance of this is the fact that Quixada, Ceará, receives 8.5 inches more than its sister town of Quixeramobim, only 25 miles away. The most surprising irregularity, however, occurs in the difference between the 100.78 inches at Barreiros, on the coast of Pernambuco, and the 23.39 inches (minimum for Brazil) falling upon Pão de Assucar, Alagoas, about 160 miles distant, but at a much less distance from the ocean on the same strip of coast. The maximum rainfall of Brazil occurs, as would be supposed, in the heart of Amazonas. Here the pluviometric station at Remate dos Males registers an annual mean of 123.52 inches. But, contrary to expectation, though no month receives less than 5.65 inches, rain falls on only about 174 days of the year.

Relative humidity cannot be correlated in any way with rainfall. The minimum for Brazil, 60.7 per cent, occurs at Quixeramobim, where the rainfall is only 25.88 inches; but Pão de Assucar, which receives the least rainfall of all stations in the country, has 82 per cent humidity. Again, Barreiros with its 100.78 inches of rain has a relative humidity of 93.5 per cent, while the maximum humidity for all Brazil, 93.6 per cent, occurs at São João Evangelista, Minas Geraes, where the rainfall is but 60.42 inches.

Dr. Ferraz and his staff, particularly Drs. Herminio Silva and Luiz Rodrigues, the meteorologists under whose direction the entire bulletin was compiled, are to be congratulated upon the execution of a most interesting and instructive paper and an important contribution to meteorological science.

Ernest G. Holt

Physical and Historical Geography of Arabia

Bernhard Moritz. **Arabien: Studien zur physikalischen und historischen Geographie des Landes.** 133 pp.; maps, ills. Heinz Lafaire, Hanover, 1923. 12 x 9 inches.

Dr. Moritz is an orientalist, librarian of the Seminar für orientalische Sprachen at the University of Berlin. In the preface of this book he explains that the journals, maps, photographs, and specimens collected during an expedition in the Hejaz in the spring of 1914 became "a sacrifice of war in Suez" and that he has been unable to learn of their whereabouts. He is therefore somewhat apologetic about the publication of the present volume from which has been omitted what he had hoped would be the central and most important feature, the observations of a journey that marked the culmination of many years' work on northern Arabia.

The book, none the less, is valuable, even if not based primarily on observation in the field. It is a work of serious scholarship for which the author has drawn not only upon the writings of European travellers but more especially upon Arabic and Hebrew sources, literary, geographical, and historical. It provides what even the best of travelers' narratives usually fail to give us: a systematic account of the various physiographic features of the north Arabian deserts and of their historical background. In general the region covered lies to the south of the tract called "the north Arabian desert" in the publications noted in the present number of the *Geographical Reveiw*, pp. 150-152.

Dr. Moritz, after a brief introduction sketching the broader outlines of north Arabian physiography and geology, discusses volcanic phenomena, sandy deserts, hydrography and meteorology, and finally the problem of desiccation. A chapter is devoted to Nejd (written, however, before the full results of Philby's explorations had appeared; see the *Geogr. Rev.*, Vol. 13, 1923, pp. 484-485). The author brings to bear profound historical learning on all of these subjects, showing, for instance, that though the desolate lava tracts (*harra*) and craters which figure so strikingly in the landscape of Arabia are apparently no longer the scenes of volcanic eruptions, the memory of a time when these volcanoes were active is vividly reflected in the literature of the early period of Islam. In the chapter devoted to the Nafud, or great desert of reddish-gold sand lying between Jauf and the Shammar country, Dr. Moritz cites historical evidence to show that these sands have not materially changed their positions under the influence of the winds since antiquity, as has been the case with some sandy areas of North Africa. As testimony to the desiccation of Arabia Dr. Moritz calls attention to great changes that have taken place in the character of plant and animal life in historical times. About the year 600 A.D. trees appear to have been far more abundant in the Hejaz and Nejd than they now are and the cultivation of the vine more widespread.

The last part of the book is devoted to the problem of the Ophir of the Old Testament, the land whence came the gold of Solomon, a highly controversial subject. Dr. Moritz places Ophir in southern Arabia, rejecting theories which would locate it in India or Africa.

A Study in Karstland Physiography

D. A. Wray. **The Karstlands of Western Yugoslavia.** Maps, bibliogr. *Geol. Mag.*, No. 699, Vol. 59, 1922, pp. 392–409.

In this article the author deals with the hinterland of the Adriatic coast from Scutari to Fiume. The geological structure is described, the erosive processes to which the region has been subjected, and the resulting forms of relief. A number of facts are carefully recorded in a definite and thorough fashion, which should be of the greatest assistance to those who continue the study and classification of karstlands. For example the exact dimensions and character of the edges of the poljes and dolines are given, with the frequency of flood and marsh periods. This and the description of the canali, fiordlike de-

pressions along the coast, probably drowned poljes, are valuable contributions to our knowledge of the region. The arrangement of these facts, however, is not so happy. All the phenomena described are parts of one system, evidences of the relative progress of the cycle of karst erosion in different parts of the region. Much would be gained if they were co-ordinated. The section on geological structure is an example of the advantage of correlation of this sort. The account of the main axes of folding and distribution of the strata of various ages is an excellent piece of synthesis.

The introductory paragraph and the last section, both of which deal with the human response to environment, are dealt with in so suggestive a manner as to make one hope that another article on this side of the problem may be forthcoming.

E. M. SANDERS

CORRESPONDENCE

ON THE PHYSIOGRAPHY OF THE INTERIOR OF GREENLAND

Danish Arctic Station
Disko, Greenland, August, 1923

To the Editor of the *Geographical Review:*

On the return from my recent expedition to northernmost Greenland I found in the library of the Danish Arctic Station on Disko Island the *Geographical Review* for July, 1923, in which Dr. Charles F. Brooks has published a review of the splendid work of A. de Quervain: "Ergebnisse der Schweizerischen Grönlandexpedition," and where he also has made comment on my paper: "Some New Features in the Physiography and Geology of Greenland" (*Journ. of Geol.*, Vol. 31, 1923, pp. 42–65). With the kind permission of the Editor of the *Review* I should like to make a few explanatory remarks on the points in question.

On page 447 Dr. Brooks writes (1):

> Lauge Koch, *op. cit.*, p. 45, designates Mt. Forel as "one of the highest peaks of Greenland . . . 2760 meters . . . . "; but he does not give any reason for discounting de Quervain's observation of 3440 ± 52 m., nor does he say how or by whom the altitude he gives was obtained.

and on page 453 (2):

> Lauge Koch, *op. cit.*, and de Quervain do not agree as to the probable locations and extents of the ice domes of central Greenland. Koch places the Switzerland dome very near the mountains and the coast and greatly restricts its size, and he indicates the central dome to the south of J. P. Koch's crossing instead of to the north as de Quervain has it. Since L. Koch's map (his Fig. 4) does not correspond to the observations de Quervain made along the route he traversed, the reviewer is inclined to favor de Quervain's map.

To the first comment I would reply that when I left Denmark in the summer of 1920 the final reports on the expedition of de Quervain were not yet published. I therefore had to take the information needed for my study from de Quervain's first book on this journey: "Quer durchs Grönlandeis," Zurich, 1912 (see accompanying map), where the height of Mt. Forel is stated to be just 2760 meters, which figure also has been adopted in the well-known Geology of Greenland by O. B. Bøggild ("Handbuch der Regionalen Geologie," IV, 2a, 1917). The figure 3440 ± 52 meters is thus the result of a revised computation, not published when I wrote my paper.

To the second point I would say that through the courtesy of Dr. de Quervain I had, before leaving Denmark, seen proofs of his maps, Pls. I–II, but not of his reports and therefore had not the opportunity of seeing on which observations the tracing of his contour lines is based (*op. cit.*, pp. 34–38), as my paper was written at Inglefield Gulf, latitude 78°N., and the manuscript sent away before I started for Peary Land.

Dr. de Quervain supposes his highest point to belong to a dome north of his route, and he supports this view by theodolite sights from his camp places on the ice cap to the horizon. But in the examples given on pages 36–37 he states that the distances of the horizon were only four kilometers at most. Such distances seem to me too small for a location of a depression across the whole of Greenland either south or north of his route. As will be seen by my paper I have tried to locate this probable depression after having taken into consideration all available actual heights of the mountains along both coasts of Greenland.

North of "Switzerland" de Quervain locates a new dome of large size, also to be found on my map, but here of considerably reduced area. I have connected it with the probable

horst of Angmagssalik to which "Switzerland" belongs. If this dome should extend as far northward as to Scoresby Sound, which idea is favored by Dr. Brooks, the northern part of it consequently must rest upon basaltic strata of great altitudes. But the existence of such high strata is for the present unknown.

De Quervain locates a third dome north of the route of J. P. Koch but without giving any reason for doing so. Such a location, however, does not agree with the very great heights of the mountains on both coasts *south* of this traverse, as stated in my paper. My view of this point is further favored by the rather steep ascent found by de Quervain on his inland ice trip in 1909 (in the Karajak district) and by the very low section of the northern part of the inland ice traversed by Knud Rasmussen in 1912.

LAUGE KOCH

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A BOAT VOYAGE THROUGH THE GRAND CANYON OF THE COLORADO

By Claude H. Birdseye and Raymond C. Moore*

U. S. Geological Survey

Geographical explorations in the United States have had no more interesting field than the Grand Canyon of the Colorado. The Grand Canyon was discovered in 1540 by one of the Spanish *conquistadores*, Don Lopez de Cárdenas, a captain in Coronado's expedition, in the quest for the fabled gold of the Seven Cities of Cibola; but almost nothing of its true nature was learned until barely fifty years ago. Now at last the mighty torrent which has carved this mile-deep chasm has been accurately surveyed, all the details of meander and profile have been charted, and new maps are being prepared which will portray in correct detail many geographic features heretofore unknown or in doubt.

History of Exploration

The canyon was first really explored in 1869, by Major John Wesley Powell, who started downstream from Green River, Wyo., to go through the thousand-mile stretch of canyons of the Green and the Colorado and discover their long-hidden secrets. With eleven men he embarked in four small boats, and after three months of hardship and disaster, in which instruments were lost, boats were wrecked, and three of his men deserted him, he succeeded in reaching the mouth of Virgin River. The achievements of all subsequent explorers of the river seem small or insignificant when we remember that Powell knew almost nothing of the rapids or falls that lay before him. His party made a reconnaissance survey of the river, but, as many of the notes were lost, he decided to make another trip. His second expedition left Green River, Wyo., in May, 1871, and, fortified by its previous experience, proceeded down the river more easily and made

* Published by permission of the Director of the U. S. Geological Survey.

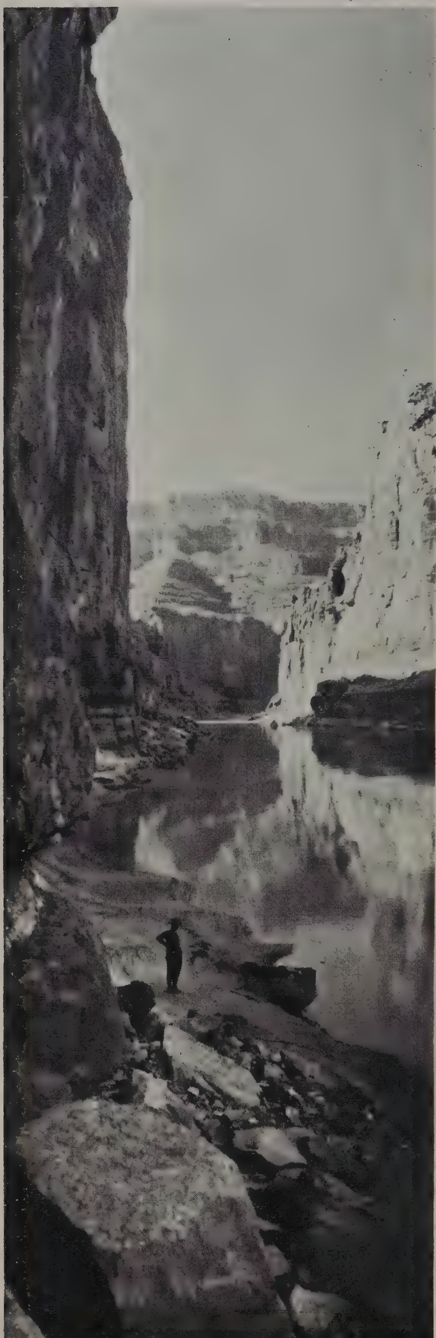

FIG. 1—Looking down Marble Canyon from a point 37 miles below Lees Ferry. (Photograph by E. C. La Rue.)

more complete observations but was stopped at the mouth of Kanab Creek by high water. Powell later became the second Director of the Geological Survey, and his early explorations have always been an incentive to members of that organization to complete the surveys he thus began.

While the Powell party was making its second voyage through the upper canyons, Lieut. George M. Wheeler, accompanied by G. K. Gilbert, geologist, and a large party, was battling his way upstream through the lower end of Grand Canyon. Although Powell had descended this part of the canyon two years before, he had been compelled to travel with the utmost speed and had scant time for observation. The work of the Wheeler expedition therefore added much to our information. The party met appalling obstacles and succeeded in reaching their objective, the mouth of Diamond Creek, only by almost superhuman effort in the face of starvation.

In order to determine the feasibility of constructing a railroad through the region an expedition was organized in 1889 by Frank M. Brown. This expedition encountered tremendous difficulties, mainly because the boats were not fit for navigating rough water, and was abandoned when Brown and two other members of the party were drowned in the upper part of Marble Canyon. Undaunted by these mishaps Robert Brewster Stanton, the chief engineer of the Brown party, at once organized a new expedition, which successfully

traversed the waters of Marble and Grand canyons and continued to the Gulf of California.

In 1896 Nathan Galloway, a Utah trapper, with one companion, made the complete voyage through the canyons from Wyoming to Needles. Galloway designed the type of boat which has since been used almost exclusively in the canyons of the Colorado, and later parties have profited much by his careful study of the features and conditions of the river. During the same year George Flavell and one companion traversed the Colorado from Green River, Wyo., to Yuma, Ariz. Little is known about this expedition except that one flat-bottomed boat was used and that the trip consumed four months. In 1907 Charles Russell and E. R. Monett journeyed from Green River, Utah, through Cataract, Marble, and Grand canyons, using steel boats somewhat similar to Galloway's wooden boats. They lost one boat at the upper end of the Grand Canyon but completed the voyage in the other. In 1909 Julius Stone, accompanied by Galloway and three other companions, made the voyage through the canyons. Galloway's experience in 1896 proved invaluable, and the party made the trip with less difficulty than had been encountered during any other voyage down the canyon, both Stone and Galloway taking their own boats through without an upset or serious accident. In 1911 Emery and Ellsworth Kolb, scenic photographers of the Grand Canyon, made an adventurous and successful voyage from Wyoming to the Gulf of California.

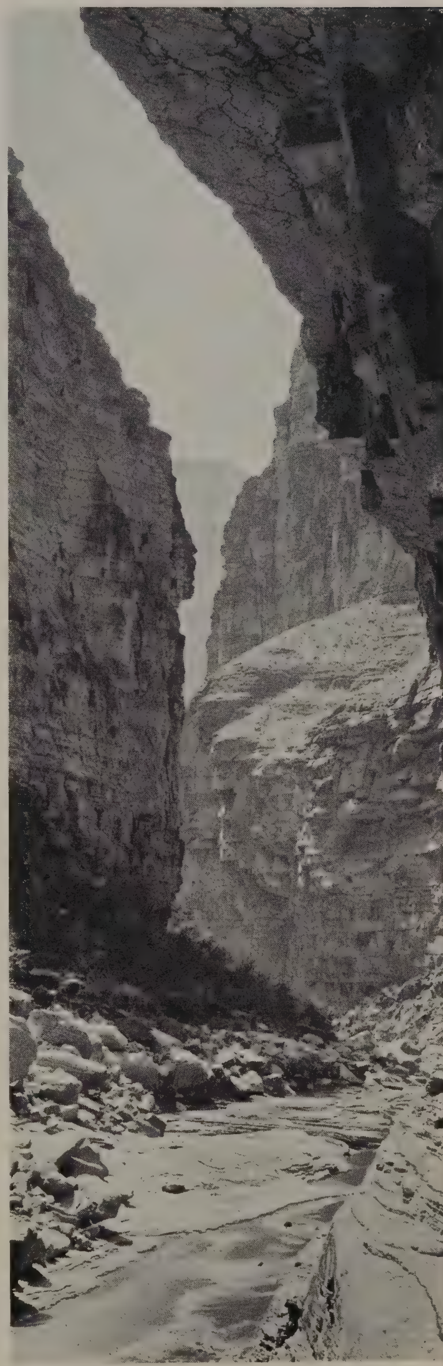

FIG. 2—Looking down canyon of Kanab Creek from a point one mile above its mouth. (Photograph by E. C. La Rue.)

After 1911 no successful attempt was made to navigate the waters of the Grand Canyon until the summer of 1923. For a number of years the Geological Survey had been making surveys along the Colorado and its tributaries, mainly with a view to controlling and properly utilizing the wasting waters. Surveys had been made along all of the river except the stretch through the Grand Canyon, and it was to fill in this gap that the expedition here described was organized. The Survey expedition had the benefit of the experiences of other expeditions as well as much more accurate knowledge of the country to be traversed than had been available to earlier explorers. The credit for the successful navigation of this stretch of the river, which includes some of the roughest water in the United States, must go to the boatmen of the party, who had had experience on the Colorado and were charged with the responsibility of getting the boats through the rapids. Their success made possible the engineering work and scientific studies undertaken by the party.[1]

The Start at Lees Ferry

Leaving Flagstaff, Ariz., on July 18, with loads of equipment, food supplies, and one new boat, we started for Lees Ferry, 140 miles to the north, where the three old boats that were to be used had been stored. These required complete, careful overhauling before they could be started on the long journey downstream. The scene of our two weeks' final preparation for the canyon journey, Lees Ferry, is a place of unusual geologic and geographic interest. It is the only place for hundreds of miles up or down stream where the Colorado River can be approached without a descent into a forbidding canyon. Here the massive, thick sandstone that stretches almost interminably eastward through the country in which Glen Canyon is carved takes a sharp upward bend that forms the great wall known as Echo Cliffs and brings to the surface west of the cliffs a great thickness of soft shales that are readily worn down by erosion. Along the passageway afforded by these worn-down soft beds Mormon immigrants from southern Utah early found a way into the Arizona country south of the river, and today the only road follows the same route. From beneath the soft beds there appears to the southwest the top of the resistant Kaibab limestone, which, rising gradually but steadily, forms the capping of the plateau into which the Marble Canyon of Colorado River has been incised (Fig. 4).

At last we were ready for the start. Our little navy consisted of four wooden boats of the Galloway type, 18½ feet long by 4½ feet beam, decked over fore and aft and fitted with water-tight hatches and airtight com-

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[1] The party consisted of ten men, the scientific members being: C. H. Birdseye, chief topographic engineer of the Geological Survey, director of the party; E. C. La Rue, who for several years has been studying the problem of utilizing the waters of the Colorado River, hydraulic engineer; Raymond C. Moore, who for some time has been engaged in geologic work in Utah and Arizona, geologist. R. W. Burchard, topographic engineer, who had already surveyed the lower stretches of the river, did most of the mapping work; Emery C. Kolb was head boatman; and the party also included Lewis R. Freeman, whose book "The Colorado River" is reviewed elsewhere in this number of the *Review*.

partments. The oarsmen sat in an open cockpit in the center, running the rapids stern first, so as to have as much chance as possible to avoid the rocks and rough waves. A strong, light canvas boat was provided to aid in the work of the rodman. All the men wore life jackets, and in rough water the passengers lay face down on the decks, clinging to life lines strung along the gunwales. Light sleeping bags, air mattresses, and other equipment, including personal dunnage, which was kept to the absolute mini-

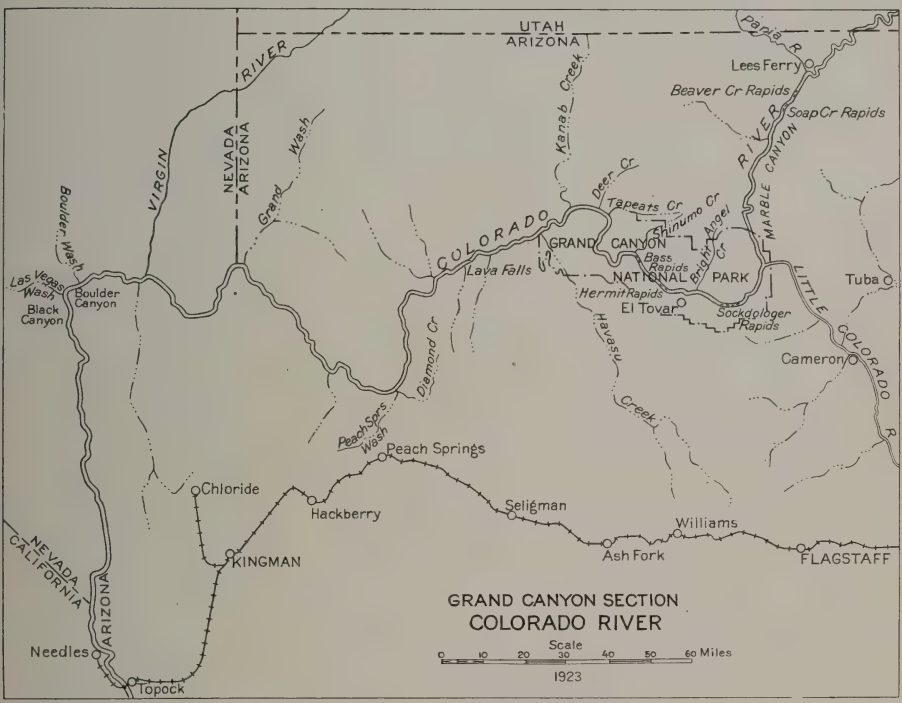


FIG. 3—Outline map of the Grand Canyon section of the Colorado River. Scale approximately 1 : 3,000,000.

mum, were packed in water-tight bags or boxes. An assortment of cameras, including two motion-picture machines, and a plentiful supply of film packed in water-tight boxes were carried. A radio receiving set had been provided and worked exceedingly well, in spite of predictions that radio communication in a deep canyon was impossible.

MARBLE CANYON

The beginning of Marble Canyon is a boxlike gorge having nearly vertical side walls rising from the river's edge. In less than four miles from the point at the mouth of Paria River where the limestone of the canyon walls first appears the hard Kaibab limestone and Coconino sandstone, which form the rim throughout Marble and Grand canyons, are exposed in their full thickness, about 550 feet, above the water, and a soft forma-

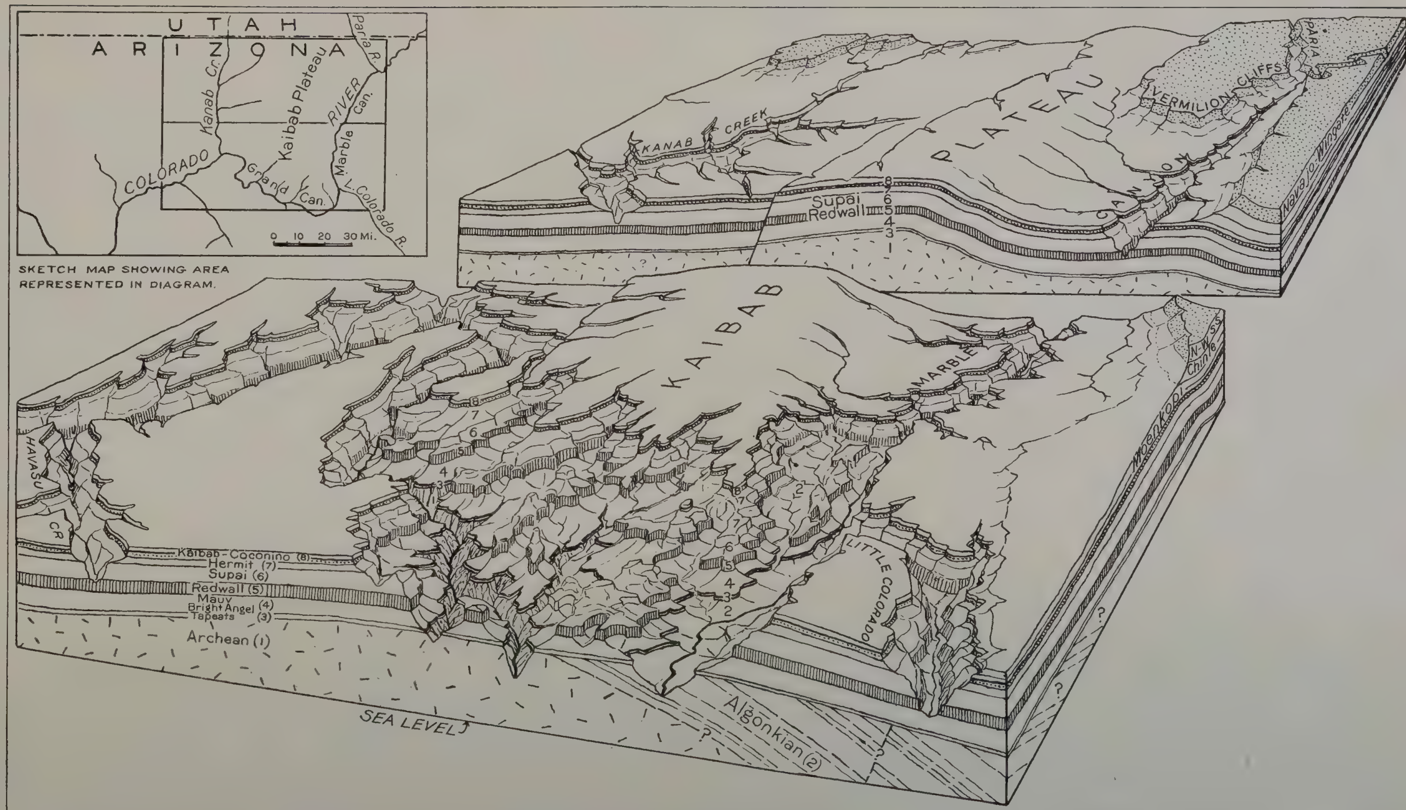


FIG. 4—Block diagram showing how the topographic features of Marble and Grand canyons are controlled by the character of the rock formations. (In the series of formation names for Mauv read Muav.)

tion, the Hermit shale, appears below. Accordingly, a slope has been formed on both sides of the river at the bottom of the canyon, and as more of the soft beds appear the height of the slope and the width of the canyon increase.

Toward the close of our first day in the canyon we reached Badger Creek rapids, the first in Marble Canyon, seven miles below Lees Ferry. These rapids have a fall of 13 feet in about 100 yards, and to us who were just beginning our trip the water looked forbiddingly rough and wild, but our experiences farther downstream made it seem in memory rather unappalling. Even in these rapids, however, the first boat struck a rock with such force that a hole was knocked in its bottom.

Soap Creek rapids, three miles below, is an exceedingly bad stretch of water, which has never been run safely by any party. We portaged the boats past the head of the rapids, carrying and skidding them for about 25 yards over the rocks to an eddy below. Perhaps we might have gone through safely without portage, as we ran worse rapids later, but it did not seem wise to take the chance so early in the trip.

A short distance below Soap Creek we found a massive, hard sandstone, the Supai formation, which appeared beneath the soft red slope-forming shale, and as the cliffs of sandstone increased in height the slope and cliffs above were lifted higher and higher above the river. At 23 miles below the Paria the rugged sandstone walls are more than 800 feet high, and the overlying slopes and cliffs add 1300 feet more to the depth of the canyon. Here the top of the greatest cliffmaker of the Grand Canyon, the Redwall limestone, appears, and farther downstream a magnificent, vertical-walled inner gorge is carved in this rock. It is this gorge, with its long stretch of swift-running water between high, smoothly polished walls of limestone, that has given to Marble Canyon its name.

Rapids after rapids followed in quick succession through Marble Canyon, at several of which the sheer walls of the canyon made portage or climbing around impossible, so that all passengers had to ride through. The traverse and level survey line was, however, carried through the canyon without a break, and many detailed surveys were made at points where construction of dams seemed feasible.

The canvas boat was lost in the thirteenth rapids in an attempt to "line" it around. The canoe might have been portaged, but as the shore was piled with enormous boulders the portage of even this light boat would have been difficult. The only other accident in the 60 miles of Marble Canyon occurred in Boulder rapids, 43 miles below Lees Ferry. A mass of rock that had recently tumbled into the center of the channel, as indicated by the scar on the canyon wall opposite and by the absence of records concerning it by previous travelers, caused the waters to divide in tremendous waves and to form a dangerous maelstrom in its lee, and here one member of the party was thrown out of his boat but recovered it without assistance.

The bottom of Marble Canyon in its lower part is composed of relatively weak beds—the Muav limestone and Bright Angel shale, which, as might be expected, form slopes. For several miles above and below the mouth of the Little Colorado the hard basal Cambrian Tapeats sandstone crops out along the river, forming cliffs that attain a height of 250 feet.

On August 13 the party reached the mouth of the Little Colorado, which poured into the main stream a flood of yellow water that was dirtier

FIG. 5—The boat *Boulder* being portaged over the rocks at the head of Soap Creek rapids. These rapids have never been run safely by any boat party. (Photograph by E. C. La Rue.)

even than that of the Colorado. This point marks the end of what is commonly called Marble Canyon and the beginning of Grand Canyon, but the whole stretch of the river through the plateau, from the Paria River downstream to the Grand Wash Cliffs, might well be called the Grand Canyon. Twenty-two rapids were encountered in Marble Canyon, and all except Soap Creek rapids were run without portage. The distance from Lees Ferry by river to the Little Colorado is 60.5 miles, and the fall is 400 feet.

Entering Grand Canyon

Only a little way below the mouth of the Little Colorado soft rocks belonging to the ancient Algonkian series begin to appear beneath the cliff of Tapeats sandstone. Four miles from the Little Colorado a great fault trending northwest elevates the rocks on the downstream side some thousands of feet and brings a great thickness of the Algonkian sediments to the surface. As these rocks are mainly rather soft the canyon here loses at once its closed-in form, the confining rims appear to recede, the lower part of the canyon is broad and open, slopes are less abrupt, and

the river, notably increased in width, winds about in leisurely fashion though still swift and not lacking in rapids.

At a point 17 miles below the Little Colorado we entered the Upper Granite Gorge, a very narrow, rugged, steep-walled, deep canyon within the Grand Canyon. The change in the character of the bottom part of the canyon is patently due to the difference in the nature of the rocks in which it is carved. These are hard, massive crystalline rocks, mostly schist and gneiss. The distinctive topography that is developed in these

FIG. 6—Cliff dwellings in the right hand wall of Marble Canyon near mouth of Nankoweap Creek. Dwellings about 600 feet above river. (Photograph by E. C. La Rue.)

rocks continues downstream as far as the river encounters this sort of rock, and it reappears in each place where crystalline rocks rise above the river.

Upper Granite Gorge and Sockdologer Rapid

The worst rapids on the river, according to report, are in the Upper Granite Gorge. One of these is known as the Sockdologer rapid, so named by Major Powell as representing the largest of all. The height of the fall at this point has been immensely exaggerated in some accounts of trips through the canyon, one recording a drop of 80 feet in a third of a mile. The fall really amounts to only 19 feet, but most of it occurs in the first 100 yards. It is impossible to climb around this rapid, and so all had to ride the boats. Seen from above the rapid, the first boat and its passengers were glimpsed only at intervals. The boat was out of sight most of the time, but finally appeared below right side up, and one by one the other boats successfully made the descent. Several other large rapids occur in the Upper Granite Gorge, but all were run without difficulty other than the usual bath of dirty water. We reached the mouth

Fig. 7

Fig. 8

Fig. 9

Fig. 10

Fig. 9—The big bend in the Colorado River 65 miles below Bright Angel Creek. (Photograph by E. C. La Rue.)
Fig. 10—Downstream view of Grand Canyon from a point 50 miles below Havasu Creek. (Photograph by E. C. La Rue.)

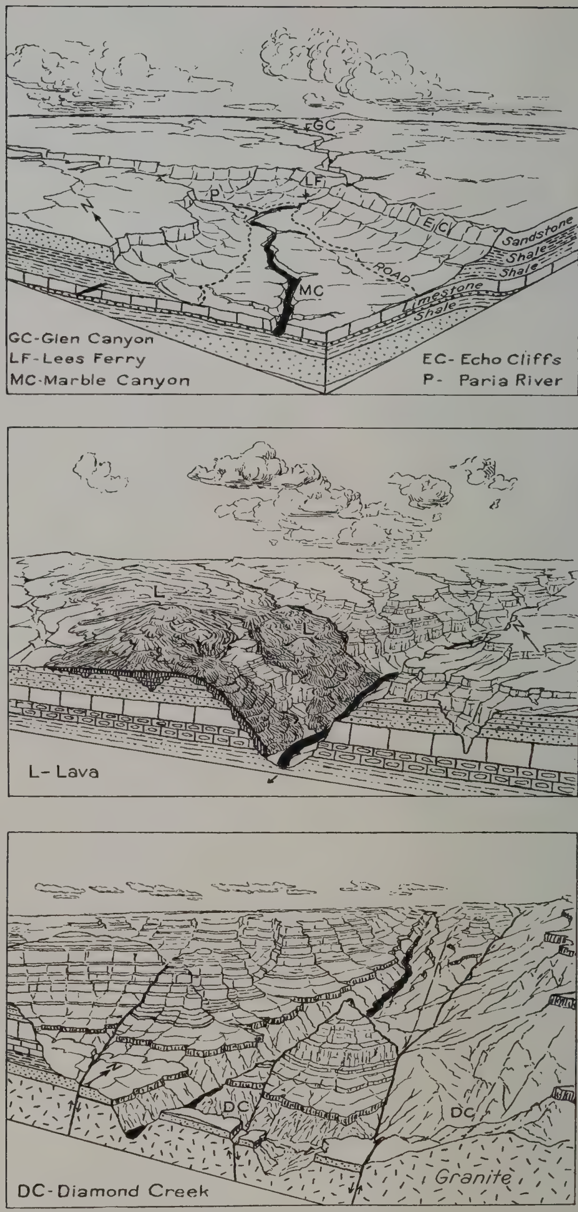


FIG. 11—Block diagrams of Colorado canyons.

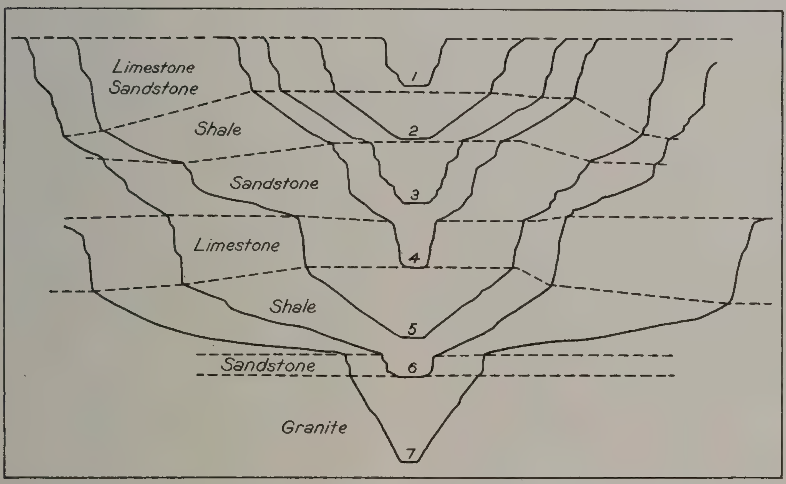
The uppermost figure shows erosion of soft strata between Glen and Marble canyons.

The middle figure shows invasion of Grand Canyon by lavas from the plateau above, near the Toroweap fault.

The lowest figure shows faulted area near Diamond Creek. The river does not follow the faults.

of Bright Angel Creek on August 23, passing under the frail-looking suspension bridge which affords the only good means of crossing in the whole Grand Canyon area. At this point we climbed to the south rim and spent three days "in civilization."

The voyage was resumed on August 27, when the boats plunged at once into a series of bad rapids below Bright Angel Creek. At Bass Canyon rapids we passed under a cable ferry 300 feet long and 50 feet above water. The cable affords a fair crossing of the river at this point, and with a man



1. Upper Marble Canyon, three miles below Paria R
2. Upper Marble Canyon, at mouth of Soap Creek
3. Upper Marble Canyon, twenty miles below Paria R.
4. Middle Marble Canyon, below Vaseys Paradise
5. Lower Marble Canyon, at mouth of Kwagunt Cr.
6. Three miles below mouth of Little Colorado R.
7. Granite Gorge above Bright Angel Creek.

FIG. 12—Profiles of Marble and Grand canyons showing the manner in which the topography and the width of the canyons are controlled by the character of the rocks.

on top of the car to operate the windlass, a horse can be carried across, if he is a tractable animal.

As has been well described by Noble[2], the crystalline walls of the inner gorge descend almost to the river in the vicinity of Bass and Shinumo creeks, where there is a considerable area of soft Algonkian rocks, in large part similar to those found above the Upper Granite Gorge. In consequence, the lower part of the canyon is more open. Not far below, however, the granite gorge resumes its typical character, which continues to the great south bend of the river around Powell Plateau. Except for a few short intervals the bottom of the canyon in Stephen and Conquistador aisles, west of Powell Plateau, consists of the lower Cambrian sediments, which produce a cross section of the canyon very similar to the lower part of Marble Canyon.

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[2] L. F. Noble: The Shi[illegible]dra[illegible], Grand Canyon District, Ariz., *U. S. Geol. Survey, Bull. 549*, Washington, D. C., 1914.

Lower Granite Gorge

A second narrow deep gorge in crystalline rocks, the so-called Lower Granite Gorge, much shorter than but otherwise similar to the first, was passed by the party. At its lower end was found another area of Algonkian strata, less extensive than those seen before.

The party ran rapid after rapid without serious difficulty until the morning of September 8, when a particularly bad rapid with a fall of 15 feet was reached at a point 70 miles below the Little Colorado. No party had yet run this rapid; but the boatmen, after carefully looking it over and testing the current by throwing into it bits of driftwood, decided that it could be run safely. Three boats went through without misadventure, but one struck a rock near the lower end of the rapid and on pulling out below was found to have suffered a bad smash in the stern. Repairs with white lead, canvas, and copper sheeting put the boat in as good shape as before.

Delaying a day at the mouth of Tapeats Creek, 72 miles below the Little Colorado, we ascended this interesting side canyon, observing the magnificent series of waterfalls, 800 or 900 feet in total height, where the nearly ice-cold water of the creek springs from the limestone cliff, and finding some old Indian ruins.

Fishtail Canyon and Kanab Creek

We reached Fishtail Canyon at noon on September 10 and saw the eclipse of the sun, which was here about 75 per cent total. It was at no time too dark to prevent work on the survey line; but in the dim light the shadows became blurred and fuzzy, and the whole canyon took on a gloomy and desolate aspect. This part of the canyon is floored by the Cambrian beds, and the bottom is accordingly not narrowly inclosed. An interesting feature, well shown on the topographic map of the Supai quadrangle, was observed just above the mouth of Fishtail Canyon. A very prominent alignment of tributary canyons trending northeast or southwest was found to follow a displacement in the rock strata, which is surprisingly small—only 23 feet where measured at the river. That night we camped at the mouth of Kanab Creek, which comes in from the north. This is the point where Major Powell abandoned his second expedition in 1871 and where he and his associates traveled up the creek to the north rim. We had hoped to find a good flow of clean, clear water here but found the stream nearly dry, and the little water that was flowing was slightly brackish.

Just below Kanab Creek, where the rock strata drop slightly faster than the fall of the river, massive limestones are brought to the water's edge, and great, nearly sheer cliffs rise 1600 feet on each side, with benches up to 2500 feet higher farther back. This is the deepest narrowly inclosed gorge that was found in the journey through the canyon. It extends essentially

without change to a point nine miles below Havasu Creek, where the soft rocks reappear in the bottom of the canyon and the walls accordingly begin to widen.

Six miles below Kanab Creek we came upon an exceedingly bad rapid, around which most of the cargo of the boats was portaged. There are

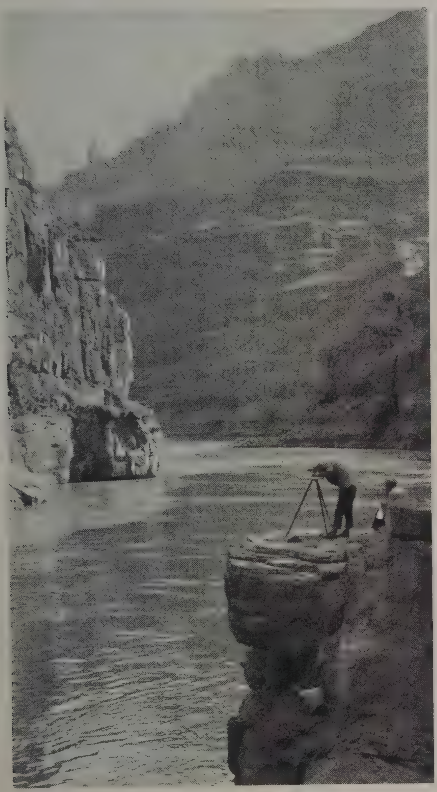

Fig. 13

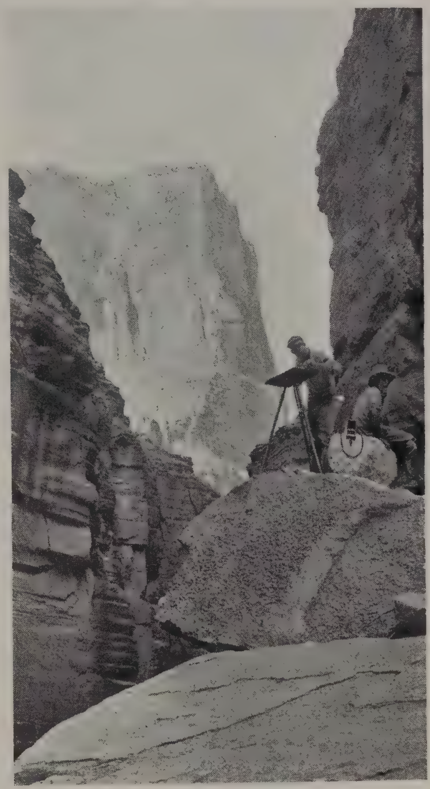

Fig. 14

Figs. 13 and 14—The topographers at work. The precipitous walls often made selection of instrument stations difficult. Figure 13 is in Marble Canyon. (Photograph by E. C. Kolb.) Figure 14 is in a side canyon 10 miles below Havasu Creek. (Photograph by E. C. La Rue.)

two big rocks in the channel near the foot of the rapids, and below each of these is a very large hole or whirlpool. Kolb, the chief boatman, ran the first boat through as usual and was drawn into one of these whirls. He was finally able to work his way out and his boat was caught at the foot of the rapid. The rest profited by his experience and maneuvered the other boats through the rapids safely.

Lava Falls

On September 13 we reached the mouth of Havasu Creek, at the west edge of Grand Canyon National Park. Here the packers had been waiting

for three days with mail and supplies. A little-used trail down from the Havasupai Indian Reservation follows the narrow, precipitous gorge of Havasu Creek and in places goes through tunnels that have been constructed to get by the falls. Nineteen Supai Indians were used to pack in the supplies, and, though the reservation is less than 10 miles from the river, none of these Indians had ever before made the trip down the steep, narrow gorge. Below Havasu the boats were run through numerous rapids with little difficulty. At 21 miles below Havasu Creek we passed a large lava pinnacle, which partly obstructs the channel but, curiously enough, forms no rapids. This is evidently the remains of a volcanic barrier, the rest of which has been eroded away by the action of the water. It is an unmistakable landmark, and voyagers by water should take warning of a very dangerous rapid, Lava Falls, a mile and a half below. The rapid is at the mouth of a canyon that comes in from the south, along the line of the Toroweap Fault, which here crosses the river, and is formed by great flows of basaltic lava from the volcanic outlets on the plateaus above. At one time the lava filled the lower part of the canyon, damming the river temporarily to a height of several hundred feet. Although the drop of Lava Falls is only ten feet, so many dangerous rocks here extend across the river that no one has attempted to run through. Portage on the left bank was easy and was accomplished largely by lining, so that the boats were seldom taken completely out of the water.

We camped at this point and at dark noticed that the river had suddenly begun to rise. The boats were moored in a rather insecure place just below the rapids and were soon pounding badly in the waves. Kolb thought he remembered a shelving beach a quarter of a mile below, and evidence of his good judgment was renewed when an excellent mooring was found just where he expected it. The river continued to rise at the rate of about 18 inches an hour and reached the peak of 21 feet the following afternoon. No one had expected such a rise, and we were up all night pulling one boat or another to a higher place on the bank. The rapid, which had been a very short, sharp-crested fall before the flood, now stretched downstream as far as the eye could see, a tumble of racing water, some of the big waves running fully 20 feet high and throwing spray much higher. Immense quantities of driftwood, including many large logs, were carried downstream. Later we learned that the volume of the river had jumped from 10,000 to 125,000 second-feet during the flood.

The river subsided slowly, and we waited four days before we could launch the boats. Proceeding downstream, we found that the invasions of lava into the canyon continued here and there for about 10 miles. We could glimpse the borders of the great lava masses and an occasional volcanic cone on the plateau above. We found clinging to the sides of the canyon near its bottom numerous flat-topped remnants of lava flows which had run many miles from the point of their entrance into the canyon, the farthest nearly 75 miles. A number of faults, some with a dis-

FIG. 15

FIG. 16

FIG. 15—The boat *Grand* running a rapid two miles above Havasu Creek. (Photograph by E. C. La Rue.)
FIG. 16—Lava Pinnacle one and one-half miles below Lava Falls. Remnant of barrier of lava which at one time completely dammed the river. (Photograph by L. R. Freeman.)

Fig. 17

Fig. 18

Fig. 17—Looking down Separation rapid. This is the point at which three of Powell's men left in 1869 and at which the boat *Grand* capsized in the 1923 expedition. (Photograph by L. R. Freeman.)

Fig. 18—Peaks near head of Diamond Creek. An example of the magnificent scenery found in nearly all of the side canyons. (Photograph by L. R. Freeman.)

placement of the rock strata amounting to several hundred feet, crossed the canyon. The number and courses of the tributary canyons are evidently affected by these dislocations, but the faults have exerted no controlling effect on the main canyon. Nine miles above Diamond Creek we entered another gorge, carved in the crystalline rocks, the beginning of the longest granite gorge in the Grand Canyon. We consumed 10 days in running the 45 miles to Diamond Creek, and the boats passed through many small rapids.

Separation Rapid

After four days' delay at Diamond Creek, during which the boats and the equipment were overhauled, the party resumed its voyage. The boats plunged through one rapid after another as we moved through the deep and narrow granite gorge, which comes to an end only 13 miles from the lower portals of the Grand Canyon. Fourteen miles below Diamond Creek we reached Separation rapid, so named by Powell to designate the point where three members of his first expedition left the canyon only to be killed by Indians while they were climbing out to the north. The sheer walls forced everyone to ride the boats through these rapids, and the deck loads made the boats top-heavy and caused them to dance about in the torrent like corks, even when the cockpits were filled with water, giving us our roughest ride since the Sockdologer. One boat was upset.

Six miles below Separation rapid we reached a very bad rapid, reported by some of our predecessors to be the worst in the canyon. A lava cliff on the right bank just above the rapid is a landmark which suggests the name Lava Cliff rapid. Our boats were lined through the upper part by using long ropes held by men stationed at several points along the high cliff and were portaged around the lower part by taking them completely out of the water and dragging them over the rocks. The job of handling 900-pound boats was not easy, and a difficult portage of equipment added to the task; but this is the last bad rapid on the river.

The End of the Survey

On October 13 we finished our actual survey work, joining surveys carried from below upstream in 1920. We had carried our line for 251 miles without a break, running in this distance 84 rapids and many other stretches of rough water and portaging the boats past only three rapids.

At last we passed the west portal of Grand Canyon, 214 miles below the mouth of the Little Colorado, and, favored at times with a strong downstream wind, a rare occurrence on the Colorado, we rapidly made our way toward Needles, Cal. In this stretch the river was comparatively free from rapids or riffles, and after a time it became our concern to avoid grounding on sand and mud bars in the river, spread out at some places to a width of more than a mile. As we were all eager to finish the trip, we made practically no stops until we reached Needles on the morning

of October 19 and then lost no time in getting our boats out of the water and to the railroad station. One of the boats has been shipped to Washington and placed on exhibition at the Interior Department building.

Conclusion

This latest trip through the Grand Canyon has confirmed the outstanding conclusion reached by its earlier explorers—that it reveals everywhere, even throughout its most minute features, the impress of the rock formations in which it is carved. Strikingly unparalleled though it is in the magnificence of its scale and in the clearness with which it discloses the character and relations of its beds and systems of stratified rocks, still more striking is it in its abounding evidences of the complete control that the rock formations have exercised in shaping not only its general form but its infinitely varying details. The succession of alternating cliffs and terraces; the height of each wall; the width of each bench; the open, gently sloping spaces at the bottom of the canyon in some places and the narrow precipitous gorges in others; the details of the ornamental sculpture; the vivid colors; the width and the swiftness of the river; the patterns of the tributary drainage systems—all these depend upon the character and the relations of the rocks through which the stream has carved its way to the sea. The boldness with which the nature and the divisions of the rocks in every part of the canyon are displayed and the structure is laid bare is due mainly to the aridity of the region. The Grand Canyon is thus presented to us as a field in which the geographer and the geologist can together pursue studies of far-reaching interest—studies that disclose not only the action of forces now in operation but the action of ever-present forces that have been potent through the ages since the Colorado has been forming the mighty chasm that is now reckoned among the wonders of the world.

ACROSS GASPÉ*

By Frederick J. Alcock
Geological Survey of Canada

The Gaspé peninsula may well lay claim to being the oldest part of Canada. On its shores, near the site of the present town of Gaspé Basin, Jacques Cartier in 1534 erected a cross bearing the arms of France, signifying that he took possession for his country, and in Gaspé were made some of the earliest settlements of New France. But though the oldest it is far from being the best known section of the country. Poor means of communication long kept Gaspé isolated. Its very isolation, however, has given it a peculiar charm. Here one may see an everyday life which has remained much the same for the past two and a half centuries. Here are found descendants of French, Scotch, Irish, and English pioneers who have been little affected by outside influences. In late years, however, the railway has done much to break down this isolation and to advertise the attractions of the country. Metis on the north shore, Gaspé Basin at the eastern end of the peninsula, and Percé and other attractive summer places on the south shore annually draw hundreds of tourists. Lovers of fly-fishing find no finer sport than on the salmon streams of Gaspé, and hunters are attracted by its moose and caribou. The lumber trade has brought in still other people, but even yet there is a long stretch of coast line on the north side of the peninsula which has but little communication with the outside world.

The population of Gaspé on both the north and south shores is confined to a narrow strip along the coast. The whole interior is uninhabited and only partially explored. Old lumber roads ascend some of the main valleys for short distances, but elsewhere, except along the streams where canoes can be poled, one must travel on foot. A road up the Cascapedia valley has recently given access to a very interesting part of the interior, but elsewhere it is rare that parties go in far from the coast.

Crossings of the Peninsula

In the summer of 1923, in connection with his work of examining some of the mineral resources of southeastern Quebec and more particularly in completing the geological mapping of an area in the central part of Gaspé, the writer had an opportunity of crossing the peninsula from the River St. Lawrence to the Bay of Chaleur. Though a distance of merely some eighty miles as the crow flies, such a traverse across Gaspé has been made but few times owing to the barrier presented by the belt of high country which, under the name of the Shickshock Mountains, extends along the middle

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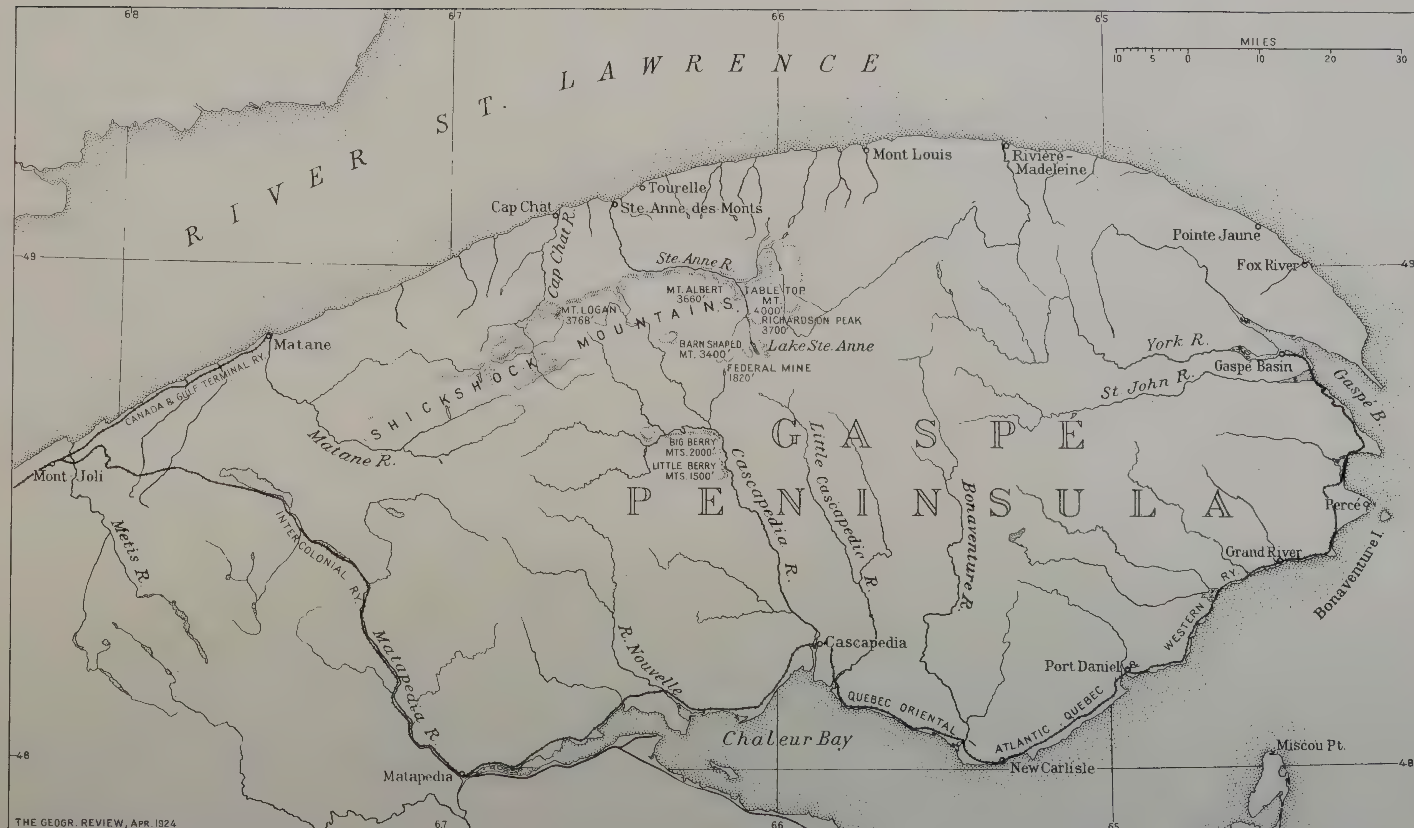

FIG. 1—Map of Gaspé showing the higher parts of the Shickshock Mountains. Scale 1:1,650,000.

of the peninsula. The Shickshocks are an extension of the Appalachian Mountain system of the eastern United States and form the highest land in southeastern Canada. Ascent to the mountains from several of the rivers which flow north to the St. Lawrence River or from the headwaters of the Cascapedia which drains to the Bay of Chaleur can readily be made and forms an interesting experience from many points of view.

The first recorded journey across the peninsula of Gaspé was made in 1844 by Sir William Logan, the founder of the Geological Survey of Canada. In 1842 Logan was brought from England to do geological exploration for the Canadian government, and his first work was an investigation of the geology of Gaspé with the object of determining the possibility of finding coal in the peninsula. His first field season was spent in studying and mapping the eastern and southern coasts. In the following year, after traversing much of the northern coast, he decided upon a trip across the peninsula to secure a complete geological section across the structure of the rock formations. He ascended the Cap Chat River by canoe to the mountains; several of the higher summits were climbed, to the highest of which his assistants gave the name Mt. Logan; and then the journey across the divide was begun. The canoes were abandoned, and with their meager equipment and supplies on their backs the party struck through the woods, Logan keeping a pace and compass traverse as he went. When southward-flowing waters were reached canoes were constructed, and the Cascapedia River was descended to its mouth. Logan's survey of his traverse across the peninsula proved to be remarkably accurate. He secured enough information to demonstrate the absence of coal in payable quantities in Gaspé.

Exploration of the rivers of Gaspé was continued by a number of Logan's assistants, principally Murray, Richardson, and Bell. It was not until 1883, however, that another traverse was made across the peninsula. In that summer, A. P. Low, who later became Deputy Minister of Mines for the Dominion government, mapped the Ste. Anne River as far as Lake Ste. Anne and from the top of Mt. Albert sketched many of the surrounding mountains. Later in the season he made a second ascent of the river to Lake Ste. Anne, portaged his canoes across to the headwaters of the Little Cascapedia River, and descended that stream to the Bay of Chaleur.

The North Shore

The route followed in the traverse described below was partly that used by Low and partly that of Logan, that is up the valley of the Ste. Anne and down that of the Cascapedia. The starting point was Ste. Anne-des-Monts where the Ste. Anne River enters the St. Lawrence.

Ste. Anne-des-Monts is one of the larger villages on the north shore of Gaspé. It can be reached either by steamer, which makes weekly trips in summer from Montreal calling at the principal ports of Gaspé, or by motor

bus which runs back and forth daily to Matane, the terminus of the Canada and Gulf Terminal Railway. The village is long and straggling, stretching out for a couple of miles along the coast. Behind it the wooded hills rise rather steeply leaving only a narrow fringe of farming land facing the shore. East of Ste. Anne-des-Monts the coast becomes still more abrupt with cliffs of limestone and shale bordering the shore for long distances.

The most striking feature of the whole north shore of the peninsula is its regular character. There are no long promontories and no deep bays to serve as natural harbors. Steamers must unload at docks built out into deep

FIG. 2—Mont Louis, on the north shore of Gaspé, showing the characteristic terraces which furnish most of the habitable land on the St. Lawrence side of the peninsula. (Photographs are by the author with the exceptions indicated.)

water, as at Ste. Anne-des-Monts, or else by lighters. The smooth curved outline of the coast follows the structure of the folded rocks of the peninsula.

Here and there along the whole coast line are located small villages—wherever an entering stream makes a break in the regular shore line. The two important industries are lumbering and fishing. At the mouth of every stream is a sawmill which takes care of the spring drive of logs. Towards the eastern end of the peninsula each little village has its fleet of fishing boats. The principal catch is cod, much of which is marketed in Italy.

Nearly all the inhabitants of the north shore are French Canadians, and but few speak or understand English. Their houses are distinctive: curved roofs, dormer windows, and long verandas are typical features used with pleasing results. Outdoor clay ovens for baking bread are seen everywhere. The main feature of every village is the large church. Many of the churches are built in part of great stone blocks cut from granite boulders carried over from the north shore of the St. Lawrence by the ice in the glacial period. Little communication takes place between the villages east of Ste. Anne. A

FIG. 3

FIG. 4

FIG. 5

FIG. 3—Pointe Jaune, a fishing village on the north shore of Gaspé. (Photograph by C. M. Barbeau.)
FIG. 4—Fox River, a fishing village on the north shore of Gaspé.
FIG. 5—Tourelle, a typical lumbering village on the north shore of Gaspé.

wagon road follows the coast around the entire peninsula, but in some places on the north shore it runs along the foot of the cliffs and in others goes back into the hills where the grades are steep. In summer it is much easier to travel along the coast by boat than to make the journey by land.

Inland from Ste. Anne-des-Monts

The first part of the journey up the Ste. Anne valley may be made either by wagon or by canoe. The river is swift, and canoes must be poled. They are rarely taken above the forks of the river, a distance of thirty-two miles. The variety of canoe used is that known as the Gaspé model. It is a narrow, heavy craft about twenty-four feet long, able to stand hard usage, and is admirably suited for swift rivers where continuous poling but no portaging is necessary. It is commonly preferred to take any load up the Ste. Anne by wagon rather than by canoe, though the road after the first few miles is so rough that its advantage over the river route is but slight. The wagons used are light affairs drawn by a single horse, and the loads taken are small. The wagon road ends at Grande Fosse Creek, about twenty-eight miles from Ste. Anne.

The Interior of Gaspé

The interior of Gaspé is a plateau ranging in elevation from about 1500 feet to 4450 feet above the sea. From any summit where a view can be obtained a remarkably even sky line meets the eye in every direction, a succession of ridges of flat-topped wooded country with only here and there a peak or summit rising slightly above the general level. The plateau is dissected by deep youthful valleys whose streams are swift and frequently torrential. The summits of a few of the higher ridges are either bare or else covered with low scrub spruce. The valleys and valley slopes are heavily wooded. On the flat interfluvial areas the plateau quite commonly presents an open-wooded parklike appearance. Travel here is much easier than in the valley bottoms. The contrast between these flat areas and the steep valley slopes is very marked.

The two highest summits near the Ste. Anne River are Mt. Albert and Tabletop, between which the valley of the Ste. Anne forms a deep-cut trench. These two mountains, adjacent but strikingly dissimilar in some respects, are in many ways the most interesting in all Gaspé. Mt. Albert is the more commonly visited since it is more accessible and is a favorite hunting ground for caribou. A fairly good trail ascending the valley of the Plaque Malade, a stream which joins the Ste. Anne two miles above the Grande Fosse, can be followed to the summit. The mountain consists of a mass of serpentine surrounded by altered volcanic rocks. Its most notable feature is the flat summit. For a length of three and a half miles and a width of two and a half the summit surface is about as flat as the western prairies; a better comparison, however, would be with the northern tundras. The surface is rock-strewn and treeless, with here and there a small pond and along the

Fig. 6

Fig. 7

Fig. 8

Figs. 6 and 7—Typical Gaspé houses. (Photograph Fig. 7 by C. M. Barbeau.)
Fig. 8—A Gaspé baking oven.

Fig. 9

Fig. 10

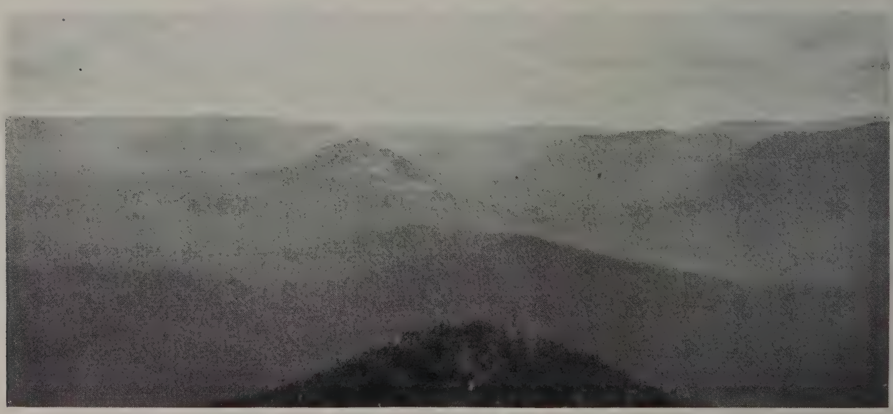

Fig. 11

Fig. 9—On the summit of Mt. Albert, showing the flat tundra-like surface.

Fig. 10—On the summit of Mt. Albert.

Fig. 11—The Ste. Anne valley from the summit of Mt. Lyall. Hogback Ridge is in the center with Mt. Albert on the left.

FIG. 12

FIG. 13

FIG. 14

FIG. 12—Botanist Dome, the highest point on Tabletop Mountain. Elevation 4450 feet.
FIG. 13—Open parklike country on the summit of Tabletop.
FIG. 14—On the summit of Tabletop.

depressions banks of snow which remain until late summer. On the contact zone of the altered volcanics (metamorphosed to a dark-colored hornblende schist) small scrub spruce grows in such dense masses that it is almost impossible to force a path through except along the caribou trails. In places the geological contact is sharply marked by this border line of vegetation. Though the area of serpentine has no trees, it offers an interesting flora of the arctic type; there is quite a variety of flowers, some of them peculiar to serpentine rocks.

FIG. 15—Lake of the Americans, a cirque lake on the west flank of Tabletop Mountain.

Mt. Albert has a maximum height of 4000 feet. On a fine day a good view of the St. Lawrence with its passing ships can be obtained, and even the north shore of the Gulf, at a distance of seventy miles, can be distinguished. Caribou are commonly to be seen, and sometimes one can get quite close to them. They apparently come to the summit during the mosquito and fly season to take advantage of the wind, which has its maximum effect on the broad exposed surface.

Tabletop Mountain on the eastern side of the Ste. Anne River presents some striking differences from Mt. Albert. The route to its summit from the valley of the Ste. Anne follows the northeastern branch for a distance of about two miles and then swings eastward towards the Lake of the Americans (Lac aux Américains)[1], a cirque lake on the western flank of the moun-

[1] The names "Lake of the Americans" and "Botanist's Dome" resulted from a botanical expedition to the region by Professors J. F. Collins, of Brown University, and M. L. Fernald, of Harvard University, in 1906. Regarding this Professor Fernald writes, "The name Lac aux Américains was given by our head guide, Samuel

tain. The summit of the mountain adjacent to the lake has an elevation of 3800 feet; but farther east one point, known as Botanist Dome, reaches an elevation of 4450 feet—the highest point in southeastern Canada. The mountain consists of granite with a fringe of older metamorphosed rocks. Its north-and-south length is about nine miles, and its width about five. All of this area is over 3000 feet in elevation. The surface is rolling, with here and there rounded domes of bare rock rising 500 feet or so above the general level. It has not the regular surface of Mt. Albert, to which the

FIG. 16—On the northeast branch of the Ste. Anne River showing huge granite boulders carried down by Pleistocene local glaciers from the side of Tabletop.

name Tabletop could have been applied much more appropriately; but its variety gives it a greater charm. On its surface are dozens of lakes and small ponds. The higher elevations consist of domes covered with huge blocks of gray and reddish granite. The depressions between are occupied in places by open parklike woods, and these with the grassy meadows and the lakes and banks of snow offer a most pleasing view on a bright day. Here and there, however, are areas of the inevitable scrubby spruce which make traverse difficult. The contrast of this open country with its variety of scenery to the wooded valleys of the peninsula where little can be seen but trees is both striking and agreeable.

Coté, and at the same time we gave various names which have been taken up, Lac Fortin and Lac Coté, for instance. These names had lasted in tradition among the guides and were first published by A. P. Coleman in Bulletin No. 34 of the Geological Survey of Canada, 1922. Coleman at that time originated the name Botanist's Dome because of the cairn on the summit built by our party.—EDIT. NOTE.

Mt. Albert and Tabletop are interesting as examples of physiographic old age. The granite intrusion of Tabletop took place in the Devonian, at which time were produced mountains which must have rivaled the present day Alps or Rockies. Through long periods of erosion the mountains were worn down. The flat surfaces of Mt. Albert and Tabletop are remnants today of this old peneplaned surface. Subsequent uplift, however, produced a rejuvenation of the streams, and valley cutting began again. The present topography of Gaspé is therefore one of youth carved beneath an earlier surface of great age.

Vertical movements of the peninsula have taken place down to recent times. Postglacial terraces are found on both the north and south shores. In fact, nearly all the habitable land on the St. Lawrence River side is in the form of raised beaches. A very prominent one, known as the Micmac beach, stands at an elevation of about 20 feet. Other beaches occur at levels up to over 400 feet. They rise perceptibly from east to west showing that the uplift was differential in character.

Glaciation

Perhaps the most interesting problem to the physiographer, however, in connection with the mountains of Gaspé is that of glaciation. Bell and Chalmers, of the Canadian Geological Survey, were both of the opinion that the Labrador ice sheet did not override Gaspé. More recently Professor A. P. Coleman, of the University of Toronto, spent two summers investigating the glacial problems of the peninsula and arrived at the same decision[2]—that the Shickshock Mountains, though occupied by local glaciers during the Pleistocene, escaped the erosion of the continental ice sheets. A climb to the top of Mt. Albert, Tabletop, Lyall, or others is enough to impress any one with this conclusion. The surface is strewn with boulders of the same variety as the bed rock. Along geological contacts there is but little overlapping of boulders of one type on the bed rock of the other. The irregular jagged knobs that project here and there would certainly have been scoured off had an ice sheet advanced over the surface, and there is an absence on the mountain summits of any smooth polished or striated surfaces such as characterize a glaciated region. The Labrador ice sheet when it reached Gaspé apparently divided into two lobes, one of which passed down the St. Lawrence valley and the other, spreading west of the higher Shickshocks, crossed Gaspé in the region of the Matapedia valley and extended eastward along the Bay of Chaleur.

Local glaciers were, however, undoubtedly present. The sides of the higher mountains present well defined cirques. The bottoms of some of these are occupied by lakes. The Lake of the Americans is of such an origin occupying a long cirque amphitheater. At the foot of the cirques are

[2] A. P. Coleman: Physiography and Glacial Geology of Gaspé Peninsula, *Canada Geol. Survey Bull. No. 34,* Ottawa, 1922.

moraines containing boulders of the rocks in place above, some of which are many times too large to have been transported by the present streams even at the time of spring floods. The interior of Gaspé was therefore a center of glaciation from which ice spread out to the north, east, and south.

From the height to which foreign boulders are found at present in Gaspé Coleman has estimated the thickness of the continental ice sheet in this region. It apparently had a thickness of less than half a mile. It is interesting to compare this figure with the estimated thicknesses of modern continental ice sheets. In Antarctica the surface of the ice sheet is nearly

FIG. 17—The Murailles, Percé. The shore is strewn with drying cod. (Photograph by C. M. Barbeau.)

level for hundreds of miles. In a distance of 1200 miles, Shackleton on his trip to the Pole found a rise of 3000 feet, which means, of course, a thickness of ice of less than this extent. It is probable that even in Pleistocene times a thickness of over half a mile was the exception rather than the rule. In Antarctica today mountains project through the ice sheet just as the Shickshocks of Gaspé must have done in Pleistocene times.

Mt. Richardson and Hogback Ridge

From Grande Fosse Creek, the end of the wagon road from Ste. Anne-des-Monts, to the Federal Zinc and Lead Mine, the end of the wagon road from Cascapedia on the Bay of Chaleur, is a distance of about twenty-two miles. A trail can be followed all the way, well cut out in part but in other places difficult to follow. It crosses and recrosses the Ste. Anne at a number of places, and every year new trees have to be felled for bridges. The writer's party made camps at suitable intervals along the route and flying camps up a number of the tributary streams. A trail leads up the valley of Poplar Creek to the Mt. Richardson country, one of the most famous of the Gaspé

summits. It has an elevation of 4000 feet, and from it can be obtained a good view of Mt. Albert to the west, and Tabletop to the east. It was named after John Richardson, one of the assistants of Logan who climbed it in 1857.

Still another mountain well worth a climb is the so-called Hogback Ridge. As the name suggests, the summit is narrow: it is 2900 feet high and bare of trees. From it one looks down the deep-cut valley of the Ste. Anne. On the west side stands the huge bare mass of Mt. Albert with a depression on its flank occupied by Devil's Lake, while on the other side rise the steep wooded

Fig. 18—A pile of dried codfish, Percé. Mt. Ste. Anne in the background. (Photograph by C. M. Barbeau.)

slopes of the plateau. To the south is an equally attractive view. There one sees the narrow summit of Mount Lyall and the red top of Sterling Mountain standing on either side of a valley occupied by Lake Ste. Anne, the source of the south branch of the Ste. Anne River. Hogback Ridge consists of fine-grained granite and is part of a continuous outcrop extending from the southern end of Tabletop westward to Barnshaped Mountain, a distance of about fourteen miles. This zone of granite is the upper part of a batholith of which the main Tabletop mass is also a part.

Lake Ste. Anne

The trail from the Ste. Anne River to the Federal Mine leaves the Ste. Anne valley about half a mile below Lake Ste. Anne. A branch trail leads to the lake, a beautiful body of water three and a half miles in length and about one half a mile in width. It is divided into three more or less distinct parts by two narrows where deltas of sand and gravel have been built by entering streams. The southern part has a depth of 120 feet. Just why such a lake should exist in the heart of the peninsula and more particularly

why, situated south of the highest mountains, it should drain northward to the St. Lawrence forms an interesting physiographic problem.

The topographic map of the surrounding region brings out the striking fact that the tributaries of the Ste. Anne River for a considerable distance below Lake Ste. Anne all head southward, suggesting an original flow of this part of the Ste. Anne River to the Bay of Chaleur. The valley in which the lake lies is also a typical river valley and continues southward to one of the upper branches of the Little Cascapedia River; in fact a dam about ten feet high at the northern end of the lake would now send the waters south-

FIG. 19—Percé, showing the village, Percé Rock, and Bonaventure Island.

ward into the Little Cascapedia. Moreover, below the outlet of the lake bed rock occurs in the stream bottom at an elevation above that of the bottom of the lake, showing that the valley where the lake now lies could not have been excavated by a stream flowing northward to the Ste. Anne. On the other hand, the Little Cascapedia River where joined by the valley in which Lake Ste. Anne lies has an elevation lower than that of the deepest point of the lake. There seems to be no doubt, therefore, that Lake Ste. Anne occupies a valley which at one time was one of the important head-waters of the Little Cascapedia. There is physiographic evidence that the change from the south-flowing to the northward drainage was caused by capture in preglacial times. The lake itself had its origin in Pleistocene time and was caused by a dam of débris brought down by streams from the high plateau country to the west of the valley at this point.

The Federal Mine

The Federal Mine is situated on a hill overlooking one of the branches of Berry Mountain Brook, a tributary of the Cascapedia River. The hill has

been cleared of trees, and from it a beautiful view down the Berry Mountain valley to Big Berry Mountain can be obtained in one direction while to the northeast rises the broad mass of Mt. Lyall with the bare reddish top of Sterling Mountain showing beyond.

Interest in this region as a mineral country was first aroused in 1910 with the discovery of lead and zinc on what is now known as the Federal hill. Claims were staked which soon were in the control of two companies, under one of which, the Federal Zinc and Lead Company, much exploration and development work has been carried out. An excellent road has been built from the Cascapedia up Berry Mountain valley to the mine, a distance of ten miles, and the old lumber road up the Cascapedia valley has been so improved by the building of bridges and betterment of the grade that it is almost a new road. Camps are located at convenient distances of every ten miles along the road. The journey from the mine by wagon to Cascapedia station, a distance of forty-six miles, usually takes either two or three days. The underground work which has been carried out at the mine so far has been of an exploratory nature. A large amount of ore has been exposed, but lack of means of transportation has prohibited active mining and milling operations.[3]

The Grand Cascapedia

As already indicated, the route from the Federal Mine to the railroad on the Bay of Chaleur coast follows down the valley of Berry Mountain Brook to its junction with the Cascapedia and thence down the Cascapedia valley. For this second part of the journey the river itself offers an alternative route, and descent by canoe is quicker and pleasanter than by road.

The Cascapedia, or Grand Cascapedia as it is commonly called to distinguish it from the Little Cascapedia, a parallel stream about ten miles to the east, is the largest river in Gaspé. It is especially noted for its salmon fishing, while the headwaters of the stream are a favorite hunting ground for moose. Moose, however, are common throughout the peninsula. In his two seasons' work the writer saw a large number and in the fall of 1921 secured a bull on Lake Ste. Anne which had antlers of fifty-two-inch spread. Caribou are fairly abundant, but the favorite hunting ground for them is Mt. Albert. Deer are less common. Bear are reported in large numbers, but in the almost daily traversing of two field seasons not a single one was encountered although traces of them were often seen. Partridges are abundant and offer a welcome addition to the camper's larder in the fall.

Settlements of the South Shore

The village of Cascapedia is situated about five miles from the coast on the Quebec Oriental Railway which runs eastward along the Bay of Chaleur

[3] For details see F. J. Alcock: Geology of Lemieux Township, Gaspé County, Quebec, *Canada Geol. Survey Summary Rept.*, 1921, pp. 71D–96D, Ottawa.

from Matapedia on the Intercolonial. It is a small village separated into two rather distinct parts by the river. It is surrounded by rolling farm land. In fact, along the whole of the Bay of Chaleur agriculture is a much more important industry than along the St. Lawrence coast. The country rises more gently, and there are broader flats along the lower portions of the rivers.

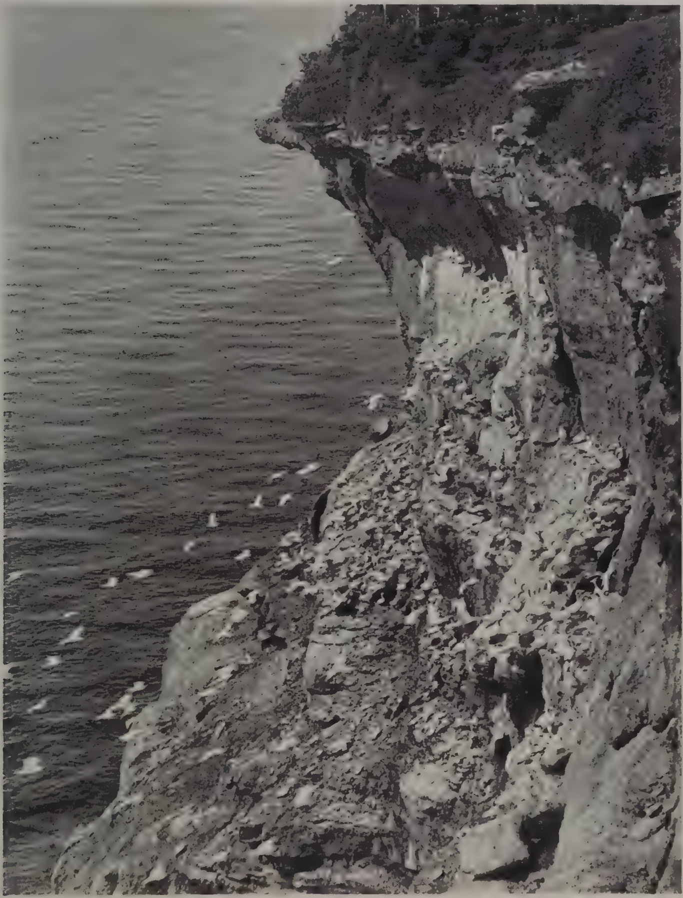

FIG. 20—Gannet Ledges, Bonaventure Island. (Photograph by P. A. Taverner.)

Another striking difference between south and north coasts of Gaspé is the character of the shore line itself. As already mentioned, the north shore is very regular, forming a broad smooth curve parallel to the structure of the folded rocks of the peninsula, with an entire absence of bays of any size. Along the Bay of Chaleur is a very irregular, varied coast. Deep bays, sandy beaches, and bay bars alternate with rock cliffs. The prevailing rock exposed in cliffs along the coast is a coarse sandstone-conglomerate formation of deep red color which makes a most attractive combination with the green of the woods and fields.

The population of the two coasts is also quite different. Along the north coast the people are mainly French Canadians of the *habitant* type. Along the south shore the Acadian French are in the majority, although here and there is found the *habitant* who has drifted in from other parts of the province. The two differ in both language and customs; as a rule the *habitant* is agricultural while the Acadian is a fisherman. Settlements of Scotch and of Irish are also to be found, sharply marked off from each other and from their French-speaking neighbors. Another important group on the southern and eastern coasts of Gaspé are the Jersey and Guernsey people who have for generations been fishermen on these coasts. In fact, from the point of view of race, language, and folklore Gaspé forms one of the most interesting parts of Canada.

Percé

No mention of the south coast of Gaspé would be complete without reference to Percé, the most interesting and beautiful point on the entire coast. Behind the village, a picturesque scene with its fleet of boats, its piles of cod, its lobster traps and fishing gear, rise the reddish cliffs of Mt. Ste. Anne, while to the immediate north of it stand the sea cliffs known as the Murailles. In front is the pierced rock from which the village takes its name, standing like a great mastless ship, 288 feet in height. Offshore at a distance of about two miles lies Bonaventure Island, whose red cliffs of flat-lying conglomerate are the nesting places of thousands of sea birds. The Island and Percé Rock are a bird sanctuary. The latter is the home of gulls and cormorants while on the former live gannets, puffins, and other species.

Of interest to the geologist is a monument which stands at Percé. On a low rock cliff in a small park is a bronze tablet to Sir William Logan. The park is known as Logan Park and has for its trustee the Geological Survey of Canada, of which Sir William was the founder. It is a fitting tribute to the man who laid the foundation for our knowledge of the geological history of Gaspé.

LOESS AND ROCK DWELLINGS OF SHENSI, CHINA

By Myron L. Fuller and Frederick G. Clapp

The character of the rural dwellings in all climes is normally determined by the nature of the materials available, their abundance, and ease of handling. In countries of advanced civilization, where transportation is highly developed, the æsthetic sense of the people may, it is true, cause the bringing in of materials, such as wood, brick, or stone, from distant points for use in dwellings. In less advanced countries, however, especially where building material can be brought from outside only by pack mules over narrow trails or by crude carts over almost impassable roads, it is inevitable that local material will be mainly utilized.[1]

Materials of unusual character commonly give rise to dwellings of like distinctiveness. Thus the loess of Shensi, China, soft and easily excavated, has given rise to peculiar artificial loess-cave dwellings. Nowhere else in the world is loess more typically or extensively developed; and probably nowhere else, except possibly in similar sections of the adjoining province of Kansu, are these novel underground dwellings so numerous or widely distributed. Yet even here an entirely different type of dwelling, the rock-cut house, is not infrequently seen where erosion has cut through the thick covering of loess into soft sandstones beneath.

The loess dwellings of Shensi, like those in other parts of northern China where loess is strongly developed, include constructional buildings of ordinary surface types as well as the cavelike excavations already mentioned.

Constructional Loess Dwellings

The constructional dwellings are square or rectangular in form, with wooden doors, mud chimneys, and one or more windows, usually admitting light through panes of translucent paper, often artistically arranged. The walls consist of loess, not infrequently mixed with rice straw or millet straw as a binder, placed while wet between forms of small rounded timbers laid horizontally, with opposing faces about a foot apart. As soon as the loess has dried and set, the forms are removed, and the surfaces, both inside and out, are given a smooth coating of loess plaster. Usually the walls are left with the natural yellowish loess color, which soon becomes, through weathering and the addition of wind-blown street dirt, drab-brown. Rarely, a coat of tinted limewash is added. Wall paper is used in a few instances.

Door and window frames are of hewn or hand-planed wood. The roofs may have a single, very gentle slope toward the rear but more commonly

[1] For illustrations see two recent articles in the *Geographical Review:* The Houses of Rural Brazil, by Roy Nash, Vol. 13, 1923, pp. 329–344; North American Indian Dwellings, by T. T. Waterman, Vol. 14, 1924, pp. 1–25.

are double-pitched, with front and rear portions of equal width and slope. These are slightly curving in the better dwellings. Roof beams are hand-hewn from trees, most frequently willows, which are usually sparingly scattered about the farmyards and villages. Upon these more or less crooked supports are placed sheets or mattings of brush stems, which are covered in turn by layers of wet loess mud, perhaps with more or less lime when this is available. The better dwellings have tiles over or replacing the

FIG. 1—Typical erosion topography in the thicker loess, showing plateau level, smooth slopes of old mature drainage, and recent gullying. Remnants of abandoned cultivation terraces are visible in the center.

mud. In some of the more elaborate structures and in those whose fronts are used as shops the corners and faces may be of smooth-faced yellow or bluish burnt brick.

Because of the limited coherency of the material, loess dwellings are never over a single story in height. The simpler dwellings consist of a single room; the larger ones may be divided by loess partitions, similar to the exterior walls, into two or more rooms. Floors are of the natural earth. On one side of the interior, a platform, *kang*, solid except for orifices for the insertion of fuel and flues for heat and smoke, is built of loess, brick, or the two combined, to a height of eighteen inches or two feet above the ground and of sufficient size to permit the inmates to stretch out to sleep upon a straw or reed mat laid upon its upper surface. Warmth is supplied by burning straw or other cheap material within the *kang* before retiring. A loess-mud chimney takes care of the smoke in most instances.

The constructional form of loess dwelling is found wherever loess occurs, either in its normal wind-blown form or in the closely similar reworked, water-deposited loess silts along the larger river bottoms as well as on the coastal plain outside of the area under consideration. In Shensi, consequently, these dwellings are distributed over the whole of the province north of the mountain face south of Sianfu. In cities practically all dwellings not of brick are of loess construction, the latter type likewise predominating in all the larger villages and even in the smaller ones that are of some age. It is only in the small scattered rural communities and in villages built since the Mohammedan rebellion that devastated northwestern China in the later sixties and early seventies of the last century, or subsequent to later depopulating droughts and famines, especially that of 1900, that they are subordinate in numbers to the loess-cave type next described.

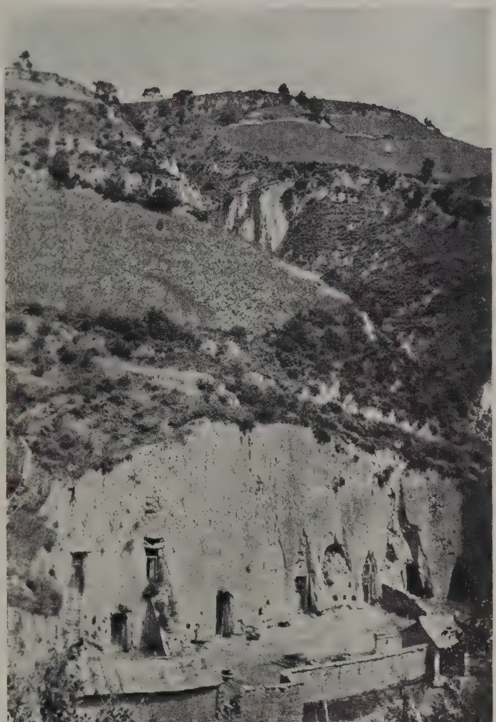

FIG. 2—Excavated dwellings in loess bluff prepared by cutting vertical face. Upper tier of dwellings probably belongs to older series, dug when terraced yard in front was at higher level. Unusual loess-stair approaches are shown on left.

The loess house of constructional type, as compared with the excavated building, is easily and quickly erected, is more ornamental and attractive, is usually more accessible and convenient, is more readily ventilated, is less liable to leaks and collapse, requires only limited amounts of loess, is independent of topography, requires less space, and can be built in friendly proximity to its neighbor. On the other hand, it requires timber, often difficult or impossible to obtain, for its wall forms and roof and is far hotter in summer and colder in winter than the cave form. Tiling and bricks are entirely unavailable in many localities.

Excavated Loess Dwellings

The loess-cave dwelling consists of a chamber or chambers of arched-tunnel form excavated within the mass of any thick accumulation of loess. The length is ordinarily about 30 feet, and the height 14 or 15 feet. The width varies with the coherency of the loess at the particular locality.

When the lime content is high, the material is more coherent and will permit widths of 15 feet or more. When the loess is less calcareous, 8 or 10 feet may be the maximum width for safety. Probably the average width is about 12 feet. In very siliceous loess, such as is not infrequently found near the rivers and which is either water-deposited or water-sorted material subsequently transported and deposited by the winds, the coherency is often so low that the excavation of dwellings is dangerous.

The side walls are usually vertical to a height of 6 to 8 feet, above which arching begins. Usually the arch is semicircular as in Figures 3 and 6; but the elliptical arch, with longer vertical axis, as in Figure 4, is also common.

When loess is wet, there is more or less likelihood of flowage; when dry, it crumbles, spalls, and caves. The best time for excavating loess dwellings is, therefore, some days or weeks after a period of rain, when the loess is still moist but no longer wet. In this condition, it is easily cut and shaped without danger, the work being done with crude shovels or other implements of wood or metal. The material is removed in baskets and dumped in front to form a terrace serving as a front yard.

After the completion of the excavation, the inner walls are surfaced with a plaster of loess mud or of loess and lime, which prevents the loess from caving, as it otherwise would, upon drying on exposure to the air and the heat of domestic fires. The floor is left in its natural condition, soon becoming hard and compact with use. In the smaller dwellings, and in storerooms, granaries, stables, etc., the door may be simply a rectangular opening left while the excavation is carried on behind (Fig. 2). In other cases the front may be walled with stone. More commonly, however, fronts with doors and windows are built by placing wet loess mud between set forms such as are used for constructional dwellings (Figs. 4 and 6). Sometimes the fronts are given decorative patterns, more often by subsequent carving than by the design of the original forms. A false arch is not infrequently cut in the loess face over the real arch to give the appearance of added height, as in Figure 4.

The excavated dwellings commonly have but a single room, but the rear is often curtained off to form a storehouse, while adjoining dwellings are occasionally connected by passages through the loess (Fig. 5*a*). Similar passages may also connect the dwellings proper with storehouses or granaries, or with barns, as illustrated by the plan, Figure 5*b*.

A *kang*, or bed platform, is built in the front part of the dwelling and an earthen stove or oven for cooking in the rear. When the surface of the ground is not too far above the loess cave, small smoke shafts are sometimes constructed. The conical, or beehive, mound in the foreground in Figure 7 represents the surface termination of such a chimney. In many instances, however, the smoke is allowed to escape into the room and find its way along the top of the arch to an opening above the door, through which it passes to the outside air.

FIG. 3

FIG. 4

FIG. 3—Loess-cave dwellings at two levels on artificially terraced edge of plateau, with constructed loess village on top.

FIG. 4—Typical loess-pit village in Kansu near the Shensi border, showing form of pit faces, elliptical arched front of cave dwelling, and yard partition with impressions of the timber forms used.

Cliff and Pit Villages

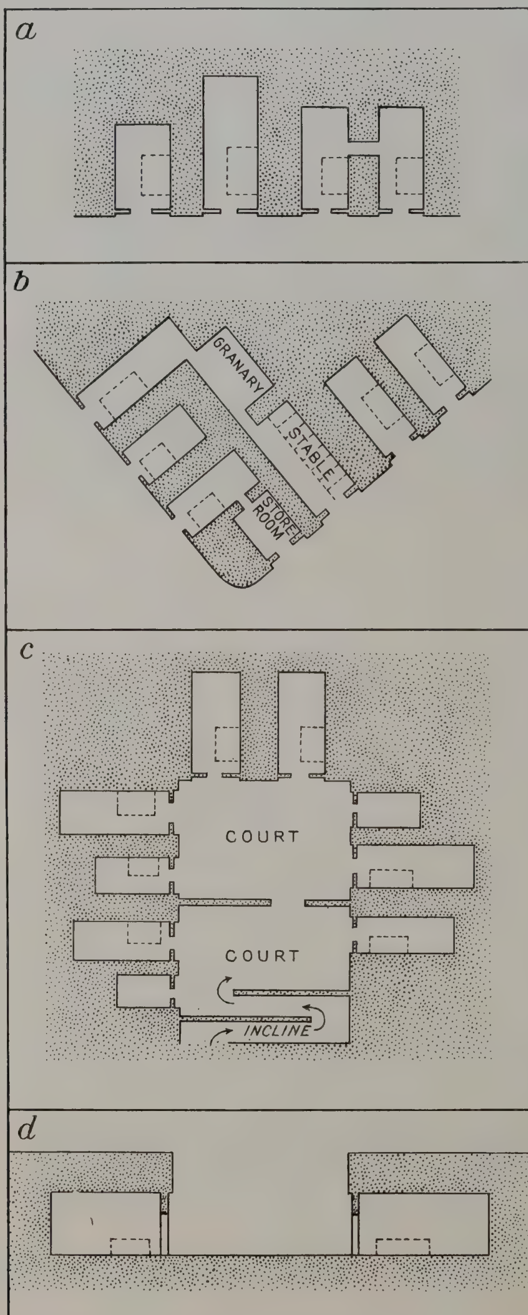

Fig. 5—Plans of loess-cave dwellings: *a* and *b*, rows of dwellings; *c*, loess-pit village; *d*, dwellings in section.

The loess cave dwelling is ordinarily dug in the face of a loess bluff. The bluff, if not already vertical, is made so before the work of excavation begins, usually being given a smooth face at the same time, as shown in Figure 2. Although loess caves are seen at two levels in this view, they are seldom or never originally constructed in this manner. In most cases, the upper series is the older, having been excavated when the yard platform or terrace in front stood at a higher level. When room for additional dwellings is required, the platform is lowered, leaving the older dwellings to be reached by ladders or, more rarely, by loess stairs, as in the figure. As a rule, the lowering is done only when the first series has begun to collapse or serious leakage through the overlying material has developed. In Figure 2 the face has been resmoothed after recutting, but not infrequently the face retains traces of the former terrace level. Figure 3 shows two terraces at the edge of a loess plateau, in both of which loess cave dwellings have been excavated. A loess village of constructional type appears on the plateau above.

So fixed has become the custom of digging caves in the vertical faces that, when no

natural cliff is at hand, the Chinese loess dwellers are impelled to make such a face artificially. On the loess plateaus, extending for miles without an inequality large enough to catch the eye, this may not appear an easy thing to do. It is accomplished, however, by first excavating a rectangular pit of perhaps an eighth of an acre in area and with vertical sides 25 to 30 feet high except at one end, where stairs are cut or, more often, an incline leading to the bottom is constructed (Fig. 6). In the sides of this pit the loess caves are excavated as in natural cliffs, the material being either removed to the plateau surface, to be used for making walls and buildings, or spread out on the ground. Figure 6 shows one of the pit villages, with a part of one of the dwellings, as seen from the top; while Figure 4 shows one as viewed from the bottom of the incline that affords access to the village.

The first essential of the cave type of dwelling is loess that is sufficiently calcareous to stand without caving. Not all of the loess possesses this requisite, the coherency varying greatly in different parts of the province. Although some very calcareous loess is found along the Hwang Ho and elsewhere in south-central Shensi, the lime content is, in general, highest in the relatively arid regions near its

FIG. 6

FIG. 7

FIG. 8

FIG. 6—Loess pit with round-arch cave dwelling in the mile-high loess plateau of northwestern Shensi.

FIG. 7—Conical, or beehive, chimney of an underground loess dwelling.

FIG. 8—Loess sink opening into an abandoned underground dwelling of the loess plateau.

supposed source in the Ordos of Mongolia or the desert regions of the northwest. In part this may be due to the more rapid deposition of the loess, which reaches its maximum development in northern Shensi and adjoining portions of Kansu, with a minimum of leaching during the process; in part to a smaller admixture of siliceous material than farther south where the material has often been water-transported and partly sorted before final deposition by winds; and in part to limited rainfall and leaching at the present time.

For these reasons, although the loess-cave dwellings are found in almost all parts of Shensi north of the Tsin-ling Range, the material is most suitable and the cave dwellings are most numerous in the north and northwestern parts of the province. In this region, the topography is likewise more favorable owing to the advanced dissection and the prevalence of natural cliffs. Although loess caves are excavated, as has been described, in the sides of large pits sunk in the smooth plateau surface, more than 99 per cent of them are dug in natural cliffs. Figure 1 is a characteristic view of the topography in the thicker and more deeply eroded loess accumulations. The plateau sky line, the smooth slopes of an old mature drainage, and the ravines and gullies of the recent period of rejuvenation are all well shown. The more rapid the recent erosion, the less the loess is leached and the more suitable it is for the excavation of dwellings.

The fact too that the region is geographically remote from other sources of building material also tends to make the loess cave most common in northern Shensi. There is but a single little-used cart road leading from the south, and this stops scores of miles from the northern border. Even the trails are steep, narrow, and few in number.

The cave dwelling, furthermore, tends to be most common in newly settled or resettled districts, in the same way that cabins and sod houses were pioneer structures in the woods and prairies of North America. Northern Shensi, again, most nearly approaches these conditions, for upon it fell the brunt of the depopulating Mohammedan rebellion of the sixties and seventies and the devastating famine of 1900. Traces of once cultivated terraces, abandoned at one or the other of these times, are found at many points and are seen in Figure 1. Only a comparatively small number of people have come back, and although a few cities have persisted, considerable areas are very thinly populated.

Because of the conditions outlined in the foregoing paragraphs, the loess cave is almost strictly a rural type of habitation, preceding the establishment of large villages. The number of cave dwellings, in the aggregate, is immense; and thousands of the inhabitants of Shensi are born, live, and die within their walls.

Loess caves, when properly cared for, last many years. When neglected, however, they soon collapse, partially or completely. Collapse is followed by a settling of the overlying material in the form of a sink, as shown by the depression in front of the opening in Figure 8, or sometimes by a loess well

such as is described and illustrated elsewhere in the *Geographical Review*.[2] On the mile-high loess plateau of northwestern Shensi many acres were found pitted with loess sinks and openings of the type shown in Figure 8, indicating the former existence of underground villages of far greater extent than anything encountered at present. These, we were told, were abandoned at the time of the Mohammedan rebellion in the late sixties. After nearly sixty years, the collapse is still far from complete. Where the

FIG. 9—Slab-roofed "boulder" hut.

covering of loess is considerable and the rainfall is light, there seems no reason why the caves should not last for a century or even longer if they are properly cared for and their interior is kept well plastered. The development of near-by villages, aside from war and famine, is probably the most potent cause of their abandonment; and even then their use as granaries and stables may continue almost indefinitely.

In times of earthquake, the loess caves become positive death traps, as was shown in adjoining sections of Kansu in the seismic disturbances of December, 1920, when the violently agitated loess flowed almost like water or crumbled into dust, accompanied by a heavy loss of life. Under ordinary circumstances, however, the loess caves afford comfortable shelters. The writers spent nearly a year in the loess region, many nights of which

[2] Myron L. Fuller: Some Unusual Erosion Features in the Loess of China, *Geogr. Rev.*, Vol. 12, 1922, pp. 570–584; see especially pp. 580–582 and Fig. 13, p. 583.

were passed in underground dwellings of the type described. Their warmth, after a day in the saddle in wintry weather, was far from unwelcome and greatly to be preferred to the benumbing cold of the *yamens* of the magistrates and other buildings of constructional types. Vermin are less common than might have been expected, the plastered walls and floors of compacted earth affording no lurking places.

Constructional Rock Dwellings

The persistency with which the Chinese cling to the cave type of dwelling, even to the extent of digging great pits to furnish the necessary loess faces for the excavation of their underground dwellings, is still further exemplified in their constructional rock dwellings along the Hwang Ho (Fig. 10). This and other large rivers have cut through the thick loess mantle and into the rock beneath to a depth of several hundred feet. Notwithstanding the fact that there is usually more or less recent loess on the rock slopes, the thinly bedded gray sandstone affords a large proportion of the building material.

Although the flat stones are admirably suited for the construction of ordinary rectangular walled and roofed buildings, this type is comparatively rare. Instead, the builders reconstruct in stone, to the best of their ability, the loess cave of their ancestors. The round arch and internal form are reproduced; the walls are plastered, the ends closed, *kangs* built, and the smoke permitted to escape in the same way. The roofs, however, are thinner, usually three to five feet in thickness, and consist of coverings of loess laid over the top of the arches and given a smooth surface. Sometimes the roof tops are surrounded by walls and used for storage purposes; sometimes they are allowed to become turfed with grass. The buildings usually contain from two to ten chambers (Fig. 10), a single-roomed structure being very rare.

A cruder type of constructional rock dwelling is that in which large boulders are utilized as sides, as in Figure 9. The roofs of such structures often consist of shaly slabs with coatings of loess mud. They are to be regarded as temporary habitations, such as would be built by shepherds, food sellers along the roads or trails, etc., and are most common where the slopes are too steep for the erection of the semi-cave type described above.

Rock Crevice and Rock-Cut Dwellings

The shelf or crevice dwellings of Shensi (Fig. 11) are comparable in situation to the cliff dwellings of America, being built on re-entrant shelves where softer layers have been weathered out from between more resistant beds of sandstone. It is not a common type, for, as a rule, the sandstones are very uniform in character and afford few benches adapted for building. Most of the shelf dwellings seen were in a single bed, more massive than usual and of limited extent, in the sandstone series (Permian?) in the vi-

FIG. 10

FIG. 11

FIG. 10—Constructed arched rock dwellings, of loess-cave design, along the Hwang Ho, eastern Shensi.

FIG. 11—Cliff dwellings on sandstone shelf, Yenanfu. The buildings are of crude type although provided with windows and chimneys.

cinity of Yenanfu in northern Shensi. The buildings here were of a crude type, although provided with windows and chimneys, as shown in the view.

Excavated, or rock-cut, dwellings are found in the more uniform sandstones, especially those approaching freestone in character. They are commonly cut in vertical faces at no great height above some rock shelf, talus slope, or loess terrace that affords a means of access. Ladders are seldom used, and rock-cut steps or approaches are uncommon.

The chambers of a single dwelling are sometimes several in number and are not infrequently on two levels (Fig. 12) connected by inside rock-cut stairways. The rooms are usually square or rectangular, with flat ceilings. Windows, doorways, and smoke openings are cut in the outer face.

FIG. 12—Rock-cut dwelling of two levels in soft sandstone in northwestern Shensi, showing weathering of openings since abandonment.

The chief advantages of these dwellings are permanency, safety, and warmth in winter against which are the disadvantages of labor of construction and comparative inaccessibility. An idea of their permanency was afforded by the dwellings of Figure 12, in which the interiors of the rooms were found smooth and unchanged as though abandoned but a few years, although the weathering of the openings in the outer walls, several of which have become united into one, apparently indicates an age of several centuries.

Rock-cut dwellings are most numerous in the massive and comparatively soft reddish Permo-Mesozoic or Mesozoic sandstones, 1000 feet or more in thickness, in the extreme northwestern and western portions of Shensi; but they are occasionally found in the gray shaly sandstones (Permian?) of central Shensi, although suitable beds in the latter are rare. Although widely distributed and of considerable numbers in the aggregate, rock-cut dwellings cannot be considered common. There are indications that many of them were originally cut as temples and were appropriated and recut into dwellings after ceasing to be used for religious purposes. They are not popular, and comparatively few are occupied at the present time.

THE QUEBRACHO REGION OF ARGENTINA

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The quebracho forests of northern Argentina and southern Paraguay have the distinction of being the only forests of their kind in existence. Here and here only, between the 20th and 31st parallels, quebracho is found in sufficient quantities to permit commercial exploitation. Quebracho as a botanical species is not entirely confined to this particular region, but in no other portion of the globe has it been found to be so abundant and of so desirable quality.

The heartwood of the quebracho yields a valuable extract highly desired in the tanning of high-grade leathers and in such demand in both Europe and the United States for the last thirty or more years that this forest product has become of great economical importance. Foreign and domestic companies, principally the former, have invested large sums of money in forest holdings and in the establishment of tannic acid factories. The industry has assumed such dimensions that it is the leading factor in the development and colonization of northern Argentina.

Besides being utilized in the manufacture of tannin, the quebracho tree is converted into many other wood products consumed domestically. Chief among these are railroad ties, boards, beams, poles, piles, fence posts, and cross arms. It is also a desirable wood for certain general construction purposes but is limited in these uses because of its heavy weight and short lengths. It is fine-grained and takes a beautiful polish as well as being the hardest, heaviest, and most durable wood known. In fact in Argentina, especially in the quebracho region, this wood is put to almost every use for which wood can be employed.

According to official statistics[1] the total area of forest land in Argentina is 264,012,000 acres, which is 36.1 per cent of the land surface. This, however, includes some burned-over forest land and also a good deal of woodland, open and scrublike. The great bulk of the forest is located in the northern part of the country. The quebracho region alone is estimated to cover 100,000,000 acres, or 13.7 per cent of the total land surface of the republic; but only 45 to 60 per cent of the region is actually timbered.

The term quebracho is of Portuguese derivation, literally meaning "break ax." Unfortunately, in parts of South America the term has been indiscriminately used, being applied to any wood having sufficient hardness to turn an ax. In the quebracho region, however, quebracho has a definite meaning, for the reason that it is practically the only wood accepted and

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[1] Raphael Zon and W. N. Sparhawk: Forest Resources of the World, 2 vols., New York, 1923; reference in Vol. 2, p. 667.

used by the tannin factories. Hence the woodmen are forced, under penalty of profitless labor, to seek the true quebracho in their operations. Two other types of quebracho are found in this region. The one is quebracho blanco (white quebracho), and the other quebracho colorado (red quebracho).[2] Both contain less tannin than the true quebracho and hence are in much less demand.

Quebracho blanco occurs in the forest composition with the true quebracho, distributed throughout the greater portion of the entire region, and is most commonly found where moisture is plentiful. The wood, a yellowish white in color, close-grained, hard, strong, and heavy, is used locally in the manufacture of such wood products as boards, cabinetwork, and cart parts.

Quebracho colorado (red quebracho), commonly known in the quebracho region as *quebracho santiagueño*, is exploited to some extent in the province of Santiago del Estero, the western part of the region, whence its name. It is used locally in the manufacture of most of the wood products to which quebracho blanco is put in other sections of the region.

The true quebracho[3] (*Quebrachia lorentzii*, of the family Anacardiaceae), commonly known in Argentina as *quebracho chaqueño* and occurring most abundantly in the province of Santa Fé and the territories of Chaco and Formosa, is the real quebracho of commerce and the quebracho with which this paper is concerned.[4]

Geographic Aspects

The quebracho region is characterized by being low-lying and monotonously flat. In fact it is so low and so flat that drainage from the area is both slow and difficult. There are many small watercourses, periodic in character, formed from the rains of the wet seasons and constituting *arroyos* during the dry seasons. A large portion of the rainfall finds no surface outlet to the sea whatever, remaining on the ground and forming *esteros*, *bañados*, *lagunas*, and *cañadas*. Evaporation and seepage remove some water, but during the rainy seasons much of the region resembles a large swamp. Railroads and houses at such times are often the only objects over leagues of land that stand free from the stagnant water.

A natural underground water system exists, but what feeds this underground water system is as yet problematical. Seepage from the Paraná River along the eastern boundary of the region and the heavy rains no doubt figure largely in its supply.

The surface soil for the most part is alluvial in character and where free from alkali is fertile. Four to ten feet of this surface soil covers a solid hard-

[2] These two species belong to the family Apocynaceae and botanically are known as *Aspidosperma quebracho blanco* and *Aspidosperma quebracho colorado*, respectively.

[3] C. D. Mell and W. D. Brush: Quebracho Wood and Its Substitutes, *U. S. Dept. of Agric., Forest Service Circular No. 202*, 1912.

[4] This article is based on the writer's experiences while connected with the quebracho industry in northern Argentina during 1922 and 1923.

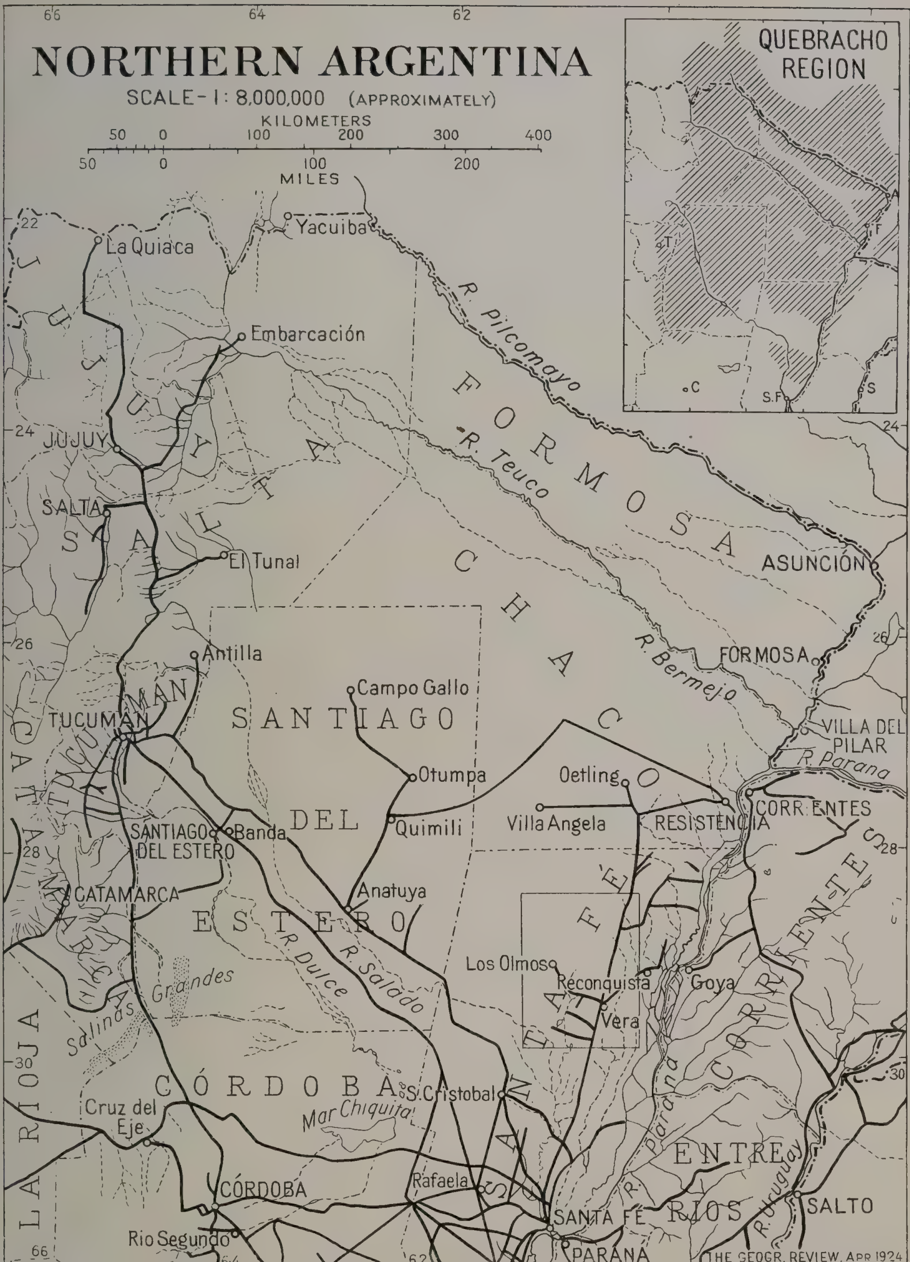

FIG. 1—Location and railway map of the quebracho country of northern Argentina. The area of the rectangle in northern Santa Fé is shown on an enlarged scale in Figure 2. The inset, on a scale of 1:26,000,000, shows by diagonal ruling the distribution of quebracho forests with their extension into Paraguay (from Zon and Sparhawk: Forest Resources of the World).

pan of several feet in thickness, through which it is necessary to bore to tap the subterranean water. During the dry season, when the surface water has either disappeared entirely or has become too stagnant for use, bored wells become a necessity of life; when they are lacking, the population suffers as much from thirst as from the excess of water during a rainy season.

The subterranean water system exhibits an interesting peculiarity. At one point water may be found to be fresh and potable while but a few feet away the water may be salt and brackish. This condition is unique, as is

Table I—Rainfall, 1911 to 1912 inclusive, at Las Gamas, Province of Santa Fé*

(In Millimeters)

	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	Monthly Average
Jan.	82	166	70.5	177	205	49	40	152	91	201	67	28	110.7
Feb.	58	58	120	130	265	86.5	758	90	86	170	148	37	167.2
Mar.	23	85	99.5	238	99	36	10	374	339	27	101	56	123.9
Apr.	64.5	191	182	529	296	83.5	71	60	21	171	25	132	152.2
May	74	142	39.5	129	151	83	42	107	99	26	6	15	76.1
June	33	83	9	66	54	4	21	38	226	37	3	47	51.7
July	48	25	4	46.5	32	27	50	7	240	53	9	69	50.9
Aug.	22	20	19.5	21	15	45	8.5	15	2.5	69	14	39	24.2
Sept.	60	16	21.5	64	22	16	54.5	49	22	31	48	166	47.5
Oct.	5	116	70.5	160	33	55	72	117	118	64	41	36	73.5
Nov.	175	158	246.5	223	53	57	15	281	90	61	32	57	120.7
Dec.	172	262	163	281	114	88	126	39	37	140	43	42	125.6
Yearly Total	816.5	1322	1045.5	2064.5	1339	630	1268	1329	1371.5	1050	537	724	

*The position of this station is approximately latitude 29° 30′ S., longitude 60° 20′ W.

the occurrence of the quebracho forests themselves. One of the explanations suggested in accounting for the occurrence of quebracho in this particular part of the world is the existence of this peculiar underground water source. It is thought that there is some definite relation between this system and the existence of quebracho. It has been established that water originating from subterranean sources within a belt or patch of quebracho forest invariably is salt and brackish, while ground water beyond the limits of any quebracho growth is invariably fresh.

In general, from the standpoint of personal comfort the climate of the quebracho region cannot be described as agreeable, though it is healthful for the most part except in the more swampy districts or during a prolonged wet season. Fanned by the hot and often humid north winds from the

interior of the continent, the region for days at a time in the summer season compares well to the blistering heat of a baking oven. At intervals these hot spells are broken for short periods by reverse winds from the south. Violent thunderstorms accompanied by torrential showers are frequent during this season. The thermometer has often been known to drop twenty-five degrees Centigrade within half an hour. In winter, the drier season, the south wind prevails, and comparatively low temperatures are experi-

TABLE II—RAINFALL FOR THE YEARS 1921 AND 1922 AT OTHER STATIONS IN THE PROVINCE OF SANTA FÉ*

(In Millimeters)

		JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Santa Felicia	1921	154	155	132	30	18	11	11	11	70	113	49	64
	1922	67	81	104	129	36	74	52	80	185	51	68	44
Intiyaco	1921	75	82	53	48	30	20	10	18	44	113	68	88
	1922	99	30	37	188	58	67	93	30	66	64	107	67
Ombú	1921	80	78	63	40	32	24	8	14	38	101	72	153
	1922	71	45	55	101	79	68	48	39	66	58	107	18

*Approximate positions: Santa Felicia, lat. 29° 25′ S., long. 60° 15′ W.; Intiyaco, lat. 28° 40′ S., long. 60° W.; Ombú, lat. 28° 20′ S., long. 60° W.

TABLE III—MAXIMUM AND MINIMUM TEMPERATURES FOR THE YEARS 1921 AND 1922 AT SANTA FELICIA, SANTA FÉ

(In Degrees Centigrade)

		JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1921	Maximum	39	36	32	32	32	29	34	34	30	31	35.5	42
	Minimum	17.5	18	12.5	9	6.5	−.4	−.3	2	6.5	2.5	8	14
1922	Maximum	42	37	36.5	35	28	27	29	27	27	32	37	40
	Minimum	13	12	12	8	4	0	7	4	7.5	9	10	15

enced. In the territory of the Chaco and the northern part of Santa Fé temperatures as low as −4° C. are observed on an average of two or three times a year between May and September.[5]

As a whole the climate of the quebracho region is variable and extreme. The rainfall varies from month to month and from year to year. It also varies markedly with different localities. In general, heavy rains are expected during the months of March and April and of November and December. The erratic nature of the distribution has been commented on by Lütgens.[6] It is illustrated in the tables of rainfall, I and II, which with Table III

[5] W. G. Davis: Climate of the Argentine Republic, Buenos Aires, 1910, p. 21.

[6] Rudolf Lütgens: Beiträge zur Kenntnis des Quebrachogebietes in Argentinien und Paraguay, *Mitt. Geogr. Gesell. in Hamburg*, Vol. 25, 1911, p. 1–70.

are from the climatological records of La Forestal, Ltda. The same feature is seen in the records from stations in Formosa and the Chaco published by the Argentine Meteorological Office in the *Boletin Mensual*.

Colonization

The northward trend of emigration into the quebracho region from the more settled sections in the southern part is coincident with the advance of the forest industry. As the more easily accessible portions of the forests are worked out and the wood supply becomes exhausted the operations advance into fresh unexploited areas. This is more particularly true of the eastern part of the region; in the west in Santiago and Salta, as Pierre Denis has pointed out, the pastoralist has led the way in many instances.[7]

In the areas of exploitation railroads and towns have been built through the medium of governmental and private aid. Much remains, however, to be done in the way of agricultural development, as the region is at present dependent on food products brought in from outside sources. Except for cattle in limited number it produces practically nothing in the way of foodstuffs. All of the towns and villages are located immediately adjacent to the railroads. Beyond a distance of five miles or so from any railroad the region is one vast wilderness.

Within a zone twenty miles in width extending along the banks of the Paraná River colonization has taken on a more serious aspect, not only on account of accessibility but also by reason of greater soil fertility. This belt is particularly adapted to the cultivation of citrus fruits, and profitable yields of other agricultural products are also secured.

One of the drawbacks to agricultural development in the quebracho region is the plague of locusts which during four months of the year—November to February—arrive in such numbers that they are beyond human control. These locust invasions lead to serious if not total losses. As the region becomes more settled and the population increases, the pest will no doubt be exterminated.

At present colonization in the interior of the quebracho region progresses only when the quebracho industry requires new territory for exploitation. The region has no attraction for the settler except the forest, and a profitable development of this resource is beyond the man of ordinary financial means. Hence colonization is slow and irregular, and from an economic aspect its progress is discouraging.

A few of the progressive ranchers of the region who have located on the numerous open *esteros* have endeavored to raise cattle as a business. Some success has been attained with this enterprise, but sooner or later it has to be associated with the forest work or it becomes unprofitable. Cattle are raised in the region in large numbers but for the most part only to supply the

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[7] Pierre Denis: The Argentine Republic, transl. by Joseph McCabe, London, 1922, p. 113.

local demand for meat, which is always limited, and for fresh bullocks for the forest work.

Exploitation of the Quebracho

The prevailing method in the region for the exploitation of quebracho forests is an extremely simple process. It consists of felling the tree by means of an ax, cutting the main trunk and the branches if over eight inches in diameter from the remainder of the tree, and then removing the white sapwood, which is usually from one to one and a half inches thick and forms about thirty per cent of the entire wood contents of the tree. The red heartwood is left in the form of a log, *rollizo*.

The *rollizos*, varying in weight from 100 kilos to 3 tons and over, are then removed from the forest by bullocks, who drag them through cut *picadas* to the carts upon which they are loaded and hauled over roughly constructed roads to the *playa*, or receiving yard. The *playas* are invariably located at a railroad terminal or siding, *desvio;* and here the *chatas*, flat cars, are loaded with the wood for further transportation to factory or seaport. Arriving at a *playa* the cart and its load of wood is weighed at the *balanza*. The *carrero* receives a receipt for the delivery of this wood and returns to the forest for a new load.

Light portable railroads of the Decauville type have been used in some instances in place of the bullock and cart, but this has not proved satisfactory. The present unsystematic methods can be greatly improved; as yet no definite plan or scheme of procedure in exploiting the forests has been tried. Present methods are based only on one principle, namely to remove the wood from forest to railroad in any convenient manner. If this happens to be an efficient undertaking so much the better, but more often it results in a miserable complexity of unprofitable human effort. The *contratistas*, forest contractors, always remove the best and most accessible material with a view to making the most immediate profit. This is the natural procedure in any country where forests are in abundance, but it is to be regretted that a resource so valuable and so limited in world distribution as quebracho is wasted in this manner.

Furthermore, every dry season thousands of tons of quebracho wood are destroyed through forest fires. No organized effort has ever been made to control them. Forest fires are recognized in the region as being damaging and unprofitable occurrences, but on the other hand the very inhabitants who acknowledge this to be so are often directly responsible for large fires. Forest fires are disliked, as even the most humble peon will assure you, but no effort will be made by him or his companions to prevent or extinguish one, except it be in the immediate vicinity of his property and family.

The work of exploiting quebracho is only profitable within limited distances from the railroads. Five kilometers is a desirable haul, while fifteen kilometers is considered a maximum haul; although quebracho logs have been hauled for much greater distances by bullocks and carts. The

five-kilometer haul is the most profitable in all kinds of weather. During a dry season a *carrero* will haul from two to three tons of wood per cart with four bullocks, for a distance of five kilometers, and make two return trips a day. In a rainy season the load must be reduced by fifty per cent at least, and the trips must be limited to one return trip a day. Often the roadbeds are not in condition to permit of even this haul. During a period of bad road conditions the *carrero* with his cart loaded often finds it too heavy for certain stretches of the muddy roads and hence must unload a portion before being able to resume the journey. Although he endeavors to use judgment in loading the proper amount in the beginning, soft spots in the road develop rapidly and upset his calculations.

Such transportation methods are costly. In the spring of 1923 the following prices were being paid for woods work. From 6 to 8 pesos per metric ton were paid for wood *tipo exportación*, export type, delivered in the receiving yard. This delivery cost is distributed as follows: 1.50 to 2.50 pesos to the *hachero* for felling the tree and removing the sapwood; 4 to 5 pesos to the *carrero* for hauling, furnishing his own carts and bullocks, with possibly some outside assistance; 50 centavos for loading the wood on the carts in readiness for the journey.

Hauling three tons twice a day figures from 42 to 48 pesos per cart per day. This is rather an attractive figure; but, as a matter of fact, a profit of from 5 to 10 pesos per day per cart for such work, day in and day out, is the average amount realized. Bad road conditions and the general retrogressive effects of too much water in the wet seasons and too little water in the dry seasons make forest operations difficult from a number of standpoints.

The forestry industry of the quebracho region is equally as dependent on the railroad for provisions and foodstuffs in general as it is for the transportation of its wood. The *obraje*, forest working center, has no source of food supply of its own on the spot. Potable water is extremely limited, and often the railroad is required to bring water as well as food into the region.

Reference has already been made to the hydrography. Over much of the region and particularly in the Santiago section there is a complete absence of running water of any kind. The underground water supply is little known or inaccessible and salty. In order to meet the demand for water shallow reservoirs are dug which resemble the *represas*, diked basins, on the ranches in the south. These shallow basins fill with rain water and are usable for temporary periods; but with the arrival of dry spells they become stagnant green pools, and the population has to rely on wagon cisterns or leave the work. Huret has described the provisioning of water at Quimili in Santiago del Estero. Every week 9 trains of 40 wagons each holding 20,000 liters of water leave Anatuya for the sawmills of Quimili and vicinity.[8]

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[8]Jules Huret: En Argentine: De Buenos-Aires au Gran Chaco, Paris, 1912, p. 300.

Many small *obrajeros* and *contratistas* operate independently in outlying forested sections of the region. They find a market for their cut wood at the various tannin factories. Some exploitation work as carried on by the large tannic acid concerns is done directly through administrative control, but when possible these companies prefer to secure wood from their own forest holdings by awarding contracts to numerous *obrajeros* and *contratistas* who in turn portion out their obligations to smaller operators. In every instance, however, *contratistas* and *obrajeros* are responsible to the parent concern, and their independence is curtailed especially with regard to prompt delivery of the wood to the factory centers.

The worker in the forests is of necessity an early riser, the nature of his task requiring that he devote long hours to the work. His breakfast is simple, consisting of *maté,* Paraguayan tea, sipped from a gourd. The cartmen then tie in their bullocks, which are kept over night in a near-by corral, and drive off to bring in the wood prepared by the axmen. The bullock herder takes his charges to pasture, and the *jefe,* or chief, mounts his horse to visit the camps of the axmen or to go to the *playa* for meat or provisions.

The *hacheros* generally live in tents or other types of temporary shelters conveniently located to their work but always at some distance from the *rancho* of the chief. They work stripped to the waist, squaring the felled trees into logs, balks, and railroad ties or removing the bark and sapwood, leaving the *rollizos* for exportation. They work at night by moonlight when possible to avoid the excessive heat of the day if in summer. Their food consists of large biscuits called *galletas,* which are dried and hardened to the consistency of flint. These they soften in a soup made from fresh meat or the dried salt meat, *charqui.* To this soup is added rice, maize, or *fideos,* a coarse macaroni. The favorite roast, *asado,* is made from the ribs of beef impaled on a stick and placed near the fire until sufficiently cooked. Water and coffee are the usual beverages. The native "coffee" of the region is made chiefly from beans or maize with a large percentage of chicory added to give it body.

The forest workers of the quebracho region are nomads, and as the woods become exploited they move on to fresh camping grounds, leaving the woods to revert to their former solitude—a haunt for the wild animals who creep back to revisit old scenes once silence has returned. Among these people one finds the primitive idea of hospitality in the form of an unaffected welcome and willingness to give of the best that they have. They have no thought for the morrow or what will be their lot when too feeble to work. Yet they are a happy and contented folk.

The estimated quantity of quebracho at present in the quebracho region is at best a doubtful figure. Based on a number of recent surveys, the writer places the total amount at about 150,000,000 metric tons.

The present average yearly consumption of this wood for all purposes is approximately 1,000,000 tons. The yield of quebracho per acre is very

variable. The writer has examined many acres which have tallied over 10 tons of quebracho as well as many which would produce less than a ton. Two tons of quebracho heartwood per acre is generally accepted as being the average yield. On this basis, in order to satisfy the demand, it is necessary to cut over about 500,000 acres yearly.

The forests of the quebracho region are so distributed that from 40 to 60 per cent of the area is lacking in any tree growth. Hence the estimated amount of quebracho is to be found on an area of approximately 50,000,000 acres, which, in accordance with the writer's estimate, implies an average yield of three tons of wood per acre. On this basis 333,333 acres are cut over annually to supply the demand, and 150 years will be required to exhaust the resource. Considerable discrepancy necessarily exists among calculations of this character because of the inaccuracy of the available basic data. Destruction by fire also reduces the available tonnage. It is thought that loss from this source at least equals the total amount of current growth of the forests.

The quebracho is not so slow-growing a tree as has been commonly supposed. Some 40 years will produce a tree of desirable size for the manufacture of extract.[9] Such a tree gives 200 kilos of heartwood at this age. Posts and poles can be produced in a much shorter period, 20 to 40 years.

Because of the relatively higher value of the true quebracho as compared with the red quebracho, and because of their similarity in general appearance, the latter is often substituted for the former. Urunduay, which resembles quebracho in general appearance and which is found in large quantities growing intermingled with quebracho, is also often substituted. The red quebracho has a small tannin content, Urunduay has none at all. Technically their differences are well distinguished.

Curupay bark, the wood of the Algarrobo negro tree, and the bark of two trees known as cebil, all of which are found in the vicinity of the quebracho region, have in the past been preferred domestically for tannin purposes. It is a well known and generally accepted fact that Algarrobo negro produces, by the same process as is employed in the extraction of tannin from quebracho, a quality of tannin much superior to quebracho itself; but because of the limited and scattered supply it cannot be economically manufactured.

The Forests

In general, one prevailing forest type is found throughout the entire region. This type is composed principally of quebracho species as already described. The forests grow in well defined belts and patches as a rule. They are found on the slightly elevated areas away from the *cañadas* and *esteros*. While during the rainy season the entire forest floor of the region is water-soaked and often completely covered, quebracho seems to prefer the higher localities from which the surface water drains more readily.

[9] W. D. Durland: Notes on Quebracho Colorado, *Journ. of Forestry*, Vol. 21, 1923, pp. 600-603.

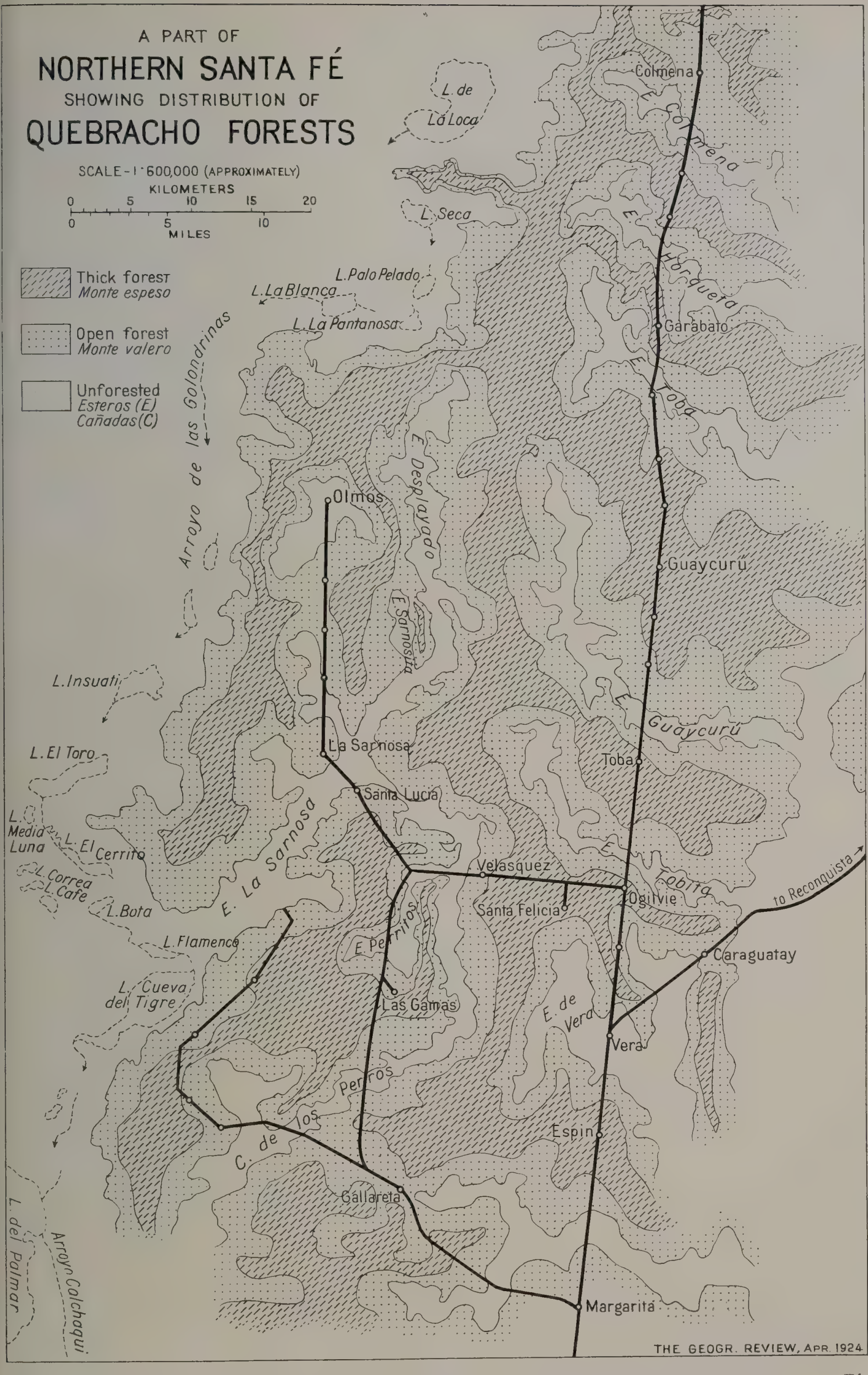

FIG. 2—Sketch map of a section of the quebracho region in the northern part of the Province of Santa Fé, showing the structure, formation, and general manner of occurrence of quebracho forests. Constructed by the author from reconnaissance notes. See the map, Figure 1, for location.

The explanation is offered that fire is in part responsible for this belted and patchy occurrence of the forests. It undoubtedly plays an important part in confining the forest growth to these well defined areas, as the *cañadas* and *esteros* are so frequently burned over that no perennial vegetation can remain established.

A perusal of the literature pertaining to the quebracho region of Argentina does not reveal the existence of any attempt to classify the wooded areas to be found therein. In the absence of such forest classification it is believed that the following will prove to be of interest. With full recognition of its limitations, the writer has found it to be adaptable and of material aid in forest work in this region.

The forest, *monte*, of the quebracho region is divided into five distinct classes, each based in part on its botanical composition but more on its utility for exploitation purposes. These five classes are as follows: (1) *Monte virgen*, or virgin forest; (2) *Monte bueno*, good forest, which may be either (*a*) *Monte ralero*, open forest, or (*b*) *Monte espeso*, thick forest; (3) *Monte de palma*, palm forest; (4) *Monte quemado*, burned forest; (5) *Monte exploitado*, cut-over forest.

Monte Virgen

The virgin forest, which is scarce in the southern half of the region, forms about eighty per cent of the forest in the northern half. The little that remains in the southern half is to be found only in small, scattered and isolated patches.

Table IV indicates the production of wood from a virgin stand of quebracho. The data are based on measurements taken on several sample plots of this class of forest, each plot being half a hectare (1.23 acres) in area. The figures given must of course be considered as representative and approximate.

Other tree species are usually found associated with quebracho in this class of forest. Algarrobo negro, algarrobo blanco, guayacan, tala, espina corona, guaranina, and molle are the most abundant.

Virgin forests of quebracho produce from 40,000 to 80,000 tons of quebracho wood per square league (= 25 square kilometers, or 2500 hectares) and greater yields per square league have been secured. Although *monte virgen* contains a greater wood volume than any other class of forest to be found in the region, its present value is more determined by its location and accessibility with reference to existing railroad lines than by its wood content.

Monte Bueno

The good forest described as *monte bueno* produces from 25,000 to 40,000 tons of quebracho heartwood per league. This class of forest may have been exploited at one time previously, but on account of its present yield of wood it is classed as above. The data in Table V, based on several sample plot observations and measurements, concern such areas of forest.

Quebracho being primarily desired for the manufacture of extract, the wood content and value of the forest are always considered from this standpoint first. A forest area may be rich in new growth, but its trees being small in size (less than 200 kilos in weight) are usable only for posts and poles. A heartwood log is required to weigh 200 kilos or more to be of economic size for factory use. As a rule the wood volume of a forest classi-

TABLE IV—PRODUCTION OF WOOD FROM A VIRGIN STAND OF QUEBRACHO*

Types		Per Hectare	Per Square League
Heartwood for extract, metric tons	Export	11.7	29,300
	Factory	5.1	12,800
Railroad ties, number		34	85,000
Large posts (enteros), number		22	55,000
Small posts (medios), number		36	90,000
Poles, number		24	60,000
Firewood (*leña campana*), metric tons		3.3	8,200
Guaranina, cubic feet		60	150,000

TABLE V—PRODUCTION OF WOOD FROM A GOOD FOREST OF QUEBRACHO*

Types		Per Hectare	Per Square League
Heartwood for extract, metric tons	Export	7.3	18,300
	Factory	6.7	16,700
Railroad ties, number		26	65,000
Large posts (enteros), number		30	75,000
Small posts (medios), number		42	105,000
Firewood (*leña campana*), metric tons		0.4	10,000
Quebracho blanco, cubic feet		14	35,000
Guaranina, cubic feet		36	90,000

*The data in these tables were secured and compiled by the writer in the quebracho region of Argentina. No tree below 200 kilos in weight was accepted as merchantable for extract purposes.

Export type logs include those cut from sound healthy trees of quebracho, free from counter curves and other undesirable forms and defects.

Factory type logs include those cut from trees of quebracho acceptable for factory use but that fail to satisfy the requirements for export material.

Railroad ties, posts, and poles in general refer to the heartwood of green quebracho, straight and sound.

Railroad ties were tallied in 2.4 meter lengths, this being considered as an average length tie. However, the estimates embrace ties of 1.8, 2.4, and 2.7 meters in length, allowing roughly one-third of the estimate for each class. A railroad tie is considered as being 12 x 24 centimeters in cross sectional dimension.

As to posts, enteros (whole posts) are 2.4 meters in length, 43 to 50 centimeters in circumference. Medios (small posts) are 2.2 meters in length, 34 to 42 centimeters in circumference. The estimates concerning each embrace from 1 to 2 per cent dead and standing material.

Poles refer to trees weighing less than 200 kilos and too large to be considered as posts, being for the most part trees 20 centimeters in diameter at the center point of the bole and 5 to 6 meters in length. The estimate embraces from 1 to 2 per cent dead and standing material.

Firewood refers to quebracho *leña campana* wood only, of dimensions 10 centimeters to 26 centimeters in diameter. *Leña campana* consists of dead and down quebracho wood from which the sapwood and bark have completely decayed.

fied as *monte bueno* is contained in a large number of trees per unit area, many of which are small in size. Additional species are also found in this class of forest, quebracho blanco being the most abundant and valuable.

This class of forest has two subdivisions that are worthy of note. *Monte ralero* is open forest, often resembling the parklike stands of the coniferous forests of the United States. It is characterized by the absence of underbrush and all understory vegetation except grass and minor herbaceous growth. It is thought that fire has brought about this condition, as the *ralero* is most abundant in the immediate vicinity of the *esteros* and *cañadas*, from which fire easily spreads into the edges of forest belts and patches. *Monte espeso* is a thick, closed stand of forest with a dense undergrowth of various herbaceous and treelike forms so interwoven one with another that passage without cutting one's way is next to impossible.

Monte de Palma

Palm forest, *Monte de palma*, is found for the most part in pure stands of from 10 to 20 trees to the acre; each tree 10 to 14 inches in diameter and from 60 to 70 feet in average height. These forests appear to be uniform in age, are open and parklike in formation, and are nearly always found on the border of the forest between the belts and patches of quebracho forest and the open *esteros* and *cañadas*. They are irregularly distributed, occurring only here and there as some peculiarity of the soil and water suits their requirements. Palma amarilla, palma negra corteza, and palma corazón are the three principal species of palm found in this class of forest. Because of their long straight and branchless trunks these trees are often cut and utilized as poles.

Monte Quemado

Monte quemado signifies burned forest. Reference has already been made to the serious destruction by fire wrought in this as in most other forest regions of the world.

From burned-over forest one class of wood only can be secured, namely, *leña campana*, or firewood. Through the associated action of fire and decay the bark and sapwood of the quebracho tree disappear, leaving the solid, weathered, and often charred heartwood. Wood of this character is undesirable for extract purposes but has a high heating value and is the best and most economical firewood obtainable in Argentina.

The approximate amount of firewood available on a burned *monte* is 3.4 metric tons per hectare, or 8500 tons per league. Obviously the amount of firewood available on burned-over areas is directly proportional to the severity of the fire. However, the fire usually passes through the forest killing the trees and other vegetation but leaving them standing in a dead charred mass. It is through the salvaging of such areas that firewood is secured.

Burned-over forest is usually exploited on contracts known as firewood exploitation rights (*derecho de leña*). These are taken up by a number of small capitalists who do not own land. They contract to remove the wood in small amounts for various purposes and do so according to the demand of the moment. *Derecho de monte*, which concerns small contracts for the exploitation of the forest proper for quebracho wood, is issued in this manner also.

Charcoal is cheaper to transport than wood and hence can be shipped farther at an equal cost. It is manufactured in the forest within easy reach of the railroads, especially in the burns which adjoin *monte ralero*, *esteros*, and *cañadas*, as through these, when dry, no roads need be built for hauling the charcoal to the railroad.

Monte Exploitado

A completely cut-over forest is classed as *monte exploitado*. Often *quebracho nuevo*, young growth or reproduction, which at the time is too small for use even as *estacones*, small stakes, is left and later develops into profitable quebracho forest. Near railroads all *montes* are well cut out of everything saleable or usable. The degree and intensity of the exploitation decreases with an increase in distance from the railroads, for the cost of transportation is the factor deciding the extent of such exploitation.

THE ECONOMIC FUNCTION OF THE RHINE

By Jacques Levainville

In the United States, river navigation, especially on the Mississippi, on the Missouri, and on the Ohio, has been unable to compete with the railroads. The railroad rates in America are lower than the river and canal rates. In Europe, where transportation problems are dissimilar in many respects, the waterways compete favorably with the railroads and are likely to continue to do so. A reduction in railroad tariffs does not seem likely for a long time. On the contrary, the cost of upkeep of the railroads and the demands of the employees are constantly increasing; additional increments of expense must be expected. To the extent that the railroads will find themselves obliged to increase their rates, their indisputable advantages (speed and flexibility) will decline and will be offset by the advantages of the water routes (large barge capacity, power of the port machinery, cheapness of transportation in bulk).

From the standpoint of economic geography the rivers prolong the great ocean routes into the interior of the lands. Of the "flowing roads" the Rhine is one of the most remarkable. It leads from the ocean into the very heart of the continent.[1]

Freedom of river communication was one of the fundamental principles of the French Revolution: "No nation can without injustice claim the right to occupy the channel of a river to the exclusion of others and to prevent the neighboring peoples who inhabit the banks of its upper course from enjoying the same privilege as they. This pretended right is a remainder of feudal servitude or at least a hateful monopoly which could only have been established by force and acquiesced in through weakness" (*Moniteur* No. 317, of November 22, 1792).

Article 5 of the First Treaty of Paris, 1814, which ended the wars of the Empire, put forth the following declaration: "The navigation of the Rhine, from the point where it becomes navigable to the sea, and vice versa,

[1] Among post-war publications consult principally: Gaston Haelling: Le Rhin: politique, économique, commercial, Paris, 1921; Emmanuel de Martonne: Conditions physiques et économiques de la navigation rhénane, Paris, 1921; A. Antoine: L'aménagement du Rhin de Bâle à Strasbourg, Paris, 1922; P. H. Schmidt: Der freie Rhein und der Wiederaufbau Europas, *Nordostschweizerischer Verband für die Schiffahrt Rhein-Bodensee Verbandsschrift Nr. 35*, St. Gall, 1921 (also in French as "Le Rhin libre et la reconstitution de l'Europe," Paris, 1922).

Among earlier publications, the following are useful: (1) Der Rheinstrom und seine wichtigsten Nebenflüsse von den Quellen bis zum Austritt des Stromes aus dem Deutschen Reich: Eine hydrographische, wasserwirtschaftliche und wasserrechtliche Darstellung, mit vorzugsweise eingehender Behandlung des Deutschen Stromgebietes. Im Auftrag der Reichskommission zur Untersuchung der Rheinstromverhältnisse herausgegeben von dem Centralbureau für Meteorologie und Hydrographie im Grossherzogthum Baden. Berlin, 1889. With an atlas of 22 plates containing general maps, 1 : 2,000,000, of the Rhine basin exclusive of Holland, showing topography, geology, hydrography, rainfall, forests, territorial divisions; a profile of the Rhine and its main tributaries; a diagram of areas subject to flood; and a detailed map in 1 : 100,000 in 17 sheets of the Rhine from Constance to the German-Dutch border. (2) E. J. Clapp: The Navigable Rhine: The Development of Its Shipping, the Basis of the Prosperity of Its Commerce and Its Traffic in 1907, Boston, 1911, with bibliography.

shall be free, in that it can be forbidden to no one." For the first time the Rhine ceased to signify a military boundary; the river was no longer exclusively a symbol of war; the economic power of the river as a transporting vehicle was recognized.

The Treaty of Versailles has again recognized these principles. The

FIG. 1—Map showing the economic resources tributary to, and the waterways connecting with, the Rhine. Scale, 1:6,800,000.

Rhine is a European and even a world problem. Free navigation on it is of importance not only to the riparian states but also to nations distant from its banks. The power of the river is felt far beyond the geographical limits of its basin. The international commission which regulates the economic life of the river is therefore justly composed not only of the representatives of the riparian states—the Netherlands, Germany, France, Switzerland—

but also of representatives of more distant states, whose interests at first thought seem less immediate—Belgium, Italy, Great Britain (Article 355 of the Treaty of Versailles).

The Geographical Conditions

The Economic Resources of the Rhine Region[2]

The developed resources of the region traversed by the river would alone assure an important activity to the waterway. This region is first and foremost a mining area (Fig. 1).

The discovery of the potash of Nonnenbruch in Upper Alsace was made, it will be remembered, in the course of a search for petroleum; the deposits amount to 300,000,000 tons, marketable without further treatment (world consumption amounted to 1,000,000 tons in 1913). Only the deposits of Catalonia and of Stassfurt are more important. Because of the dominating position of the latter the Alsatian deposits produced only 350,000 tons in 1913, but production surpassed 1,100,000 tons in 1920. It is estimated that they will be able to furnish 3,000,000 tons annually. The Alsatian potash, which does not contain magnesium, is particularly in demand in England and the United States. It will furnish an important return-freight commodity for the coal barges which ascend the Rhine to Strasbourg.

But it is rather fuels that constitute the most important part of the economic resources of the Rhine region.

The petroleum of Pechelbronn, to be sure, affects the river traffic only in a small way. The annual production hardly amounts to more than 75,000 tons of oil, and consumption is entirely local. On the other hand, the lignite of the Aachen basin and the coals of the Ruhr furnish the greater part of the river freight. The Rhine is a coal river.

The lignite basin of Cologne extends from the Rhine to the Erft, a left tributary of the Rhine, with a maximum width of 12 kilometers and maximum length of 60 kilometers. Two other small deposits lie in the latitude of Bonn to the west of the Erft and on the right bank of the Rhine opposite Cologne. The reserves are estimated to be 3,000,000,000 tons. The mines are open-pit mines. The workable seam is from 15 to 100 meters thick. In 1913, 3,629,000 tons were shipped by railroad and 667,000 tons by way of the Rhine after having been loaded at the port of Wesserling. The dearth of mineral fuels gives these lignite deposits an importance of the first rank. In 1913 the production of Germany was 87,000,000 tons of lignite as against 191,000,000 tons of coal. In 1922 the production was 134,000,000 tons of lignite as against 129,000,000 tons of coal. The lignite syndicate of Cologne is preparing to increase production. It has acquired

[2] Some of the data are conveniently accessible in "World Atlas of Commercial Geology, Part I: Distribution of Mineral Production," U. S. Geol. Survey, Washington, D. C., 1921.

a Rhine fleet which includes tugboats of a total of 5450 h. p. and barges of a total of 38,448 tons.

While this increase of activity is in the future, it is coal that at present constitutes the principal Rhine cargo. Of 54,000,000 tons transported in 1913, 22,000,000 came from Westphalia. Even so, this tonnage represents only one-seventh of the production; the rest was consumed locally by the large number of metallurgical establishments.

The reserves of the Rhine coal fields were estimated as 200,000,000,000 tons by the International Geölogical Congress in Canada, 1913, the French reserves being estimated as less than 20,000,000,000 tons.

The current of coal emanating from the Duisburg region ramifies on entering the canals and navigable rivers. It follows the Dortmund-Ems Canal; by means of the Rhine it reaches Holland, where it meets English coal, and Belgium, whither it goes in spite of Belgian collieries and English coal. To the south it goes up the Main as far as Würzburg and up the Neckar as far as Heilbronn; it reaches Switzerland and Italy after having been transferred at Mannheim to the railway. In France it ascends the Marne-Rhine Canal, where it meets the coal from the Saar. The importance of this current gives Germany a privileged position. It is true that English coals have been put on the market at Mannheim, at Strasbourg, and at Stuttgart; but these are special kinds which are suitable for a specific purpose, such as the making of gas, for instance, or they are shipments which are due to exceptional circumstances, such as strikes or shortage of fuel.

The magnitude of the coal resources led at an early period to the development of small metallurgical centers. The Lahn and the Siegen districts produced the necessary iron ore. But these resources soon became insufficient, and the metallurgical industries of the Rhine region, therefore, had to turn principally to foreign countries for their supply.

In 1913 the Zollverein (Germany and Luxemburg) produced 19,300,000 tons of pig iron with 35,911,000 tons of domestic ore and 14,000,000 tons of imported ore; of this total the domestic ore, with its 31.8 per cent of iron, could produce only 10,500,000 tons of pig iron. There remained therefore about 9,000,000 tons, or 46 per cent of the production, which were produced by means of the foreign ores, or 80 per cent if in this category be counted 8,600,000 tons of metal obtained in the Saar and in Westphalia by the fusion of the minette ores imported from Lorraine and Luxemburg. In 1913 the imported ores to the total value of 14,028,000 tons came from the following countries and in the following amounts in metric tons: Sweden, 4,558,000; France, 3,811,000; Spain, 3,651,000; Russia, 489,000; Belgium, 127,000; Austria-Hungary, 106,000; Algeria and Tunis, 607,000; Greece, 147,000; other countries, 532,000. Of this total the African and Spanish ores and the greater part of the Swedish ore, together 7,000,000 tons, came by way of the Rhine. On the other hand, the Lorraine ores were transported by railroad: hostility of the German government to the canalization of the Moselle prevented the Rhine from carrying this remunerative cargo.

As a consequence of the importance of these mineral resources the Rhine region has always been one of the most densely populated regions of Europe. From Alsace to Holland there is all along the river a density of population three times that of the average in France (75 inhabitants to the square kilometer). At every 30 kilometers, on the average, a city of 100,000 inhabitants is met with on the banks or in the immediate vicinity of the Rhine. That is the origin of the third element of the commercial movement, namely the cereals.

This current has increased parallel to the growth of population from 1900 to 1912, but it has remained an import current directed almost exclusively upstream. It grows weaker from north to south; nevertheless it still reaches Strasbourg. The very weak downstream movement is due particularly to the reshipment of flour. The cereals come from Russia, Rumania, the United States, and Argentina. The share of Russia was before the war the largest (40 per cent); then came Rumania, the United States, and Argentina. The sources of the current are in the Belgian and Dutch ports.

The fuels, the ores, and the cereals constitute four-fifths of the Rhine freight. These are heavy commodities. They naturally prefer the water to the rail route. Their places of origin and their destination show that to transport them concerns not only the riparian states, which use or transform these commodities, but also more distant countries, through which they pass in transit or from which they are shipped.

The Economic Zone of the Rhine

Among the riparian states Belgium and Holland occupy a position by themselves. Traffic between the Rhine and the group of three ports, Amsterdam, Rotterdam, and Antwerp, in 1913 amounted to 14,000,000 tons from the Rhine and 18,000,000 tons to the Rhine. The most important elements of this traffic are coal (9,000,000 tons), iron ore (8,000,000 tons), and cereals (4,000,000 tons). The Belgian ports dispatched 8,000,000 tons by way of the Rhine in 1912, more than the tonnage of Mannheim and Ludwigshafen combined.

"In the Rhine fleet," writes Emmanuel de Martonne, "the Netherlands and Belgium hold an important place. Of 1671 steamboats 748, or 45 per cent, were German; 711, or 43 per cent, were Dutch; 212, or 12 per cent, were Belgian. Through the great coal port of Duisburg pass almost as many Dutch boats (22,597) as German boats (27,075). . . . At Cologne there are still 1742 Dutch boats and 1007 Belgian boats. Even at Strasbourg 276 Dutch boats and 122 Belgian boats were noted in 1912."

To Switzerland the importance of the river is not less. For Switzerland the Rhine is the only free outlet towards the ocean, the only route by which it can secure the indispensable raw materials for its industries, whose development has been especially rapid but whose future is uncertain because of geographical conditions. The economic future of Switzerland is

dependent on Westphalian coal. Of a total of imported coal covering the period 1908–1912 at an annual value of 83,000,000 francs, Germany contributed 71,000,000 francs' worth. The remaining 12,000,000 francs' worth probably is coal in transit and consists of a certain amount of German coal. It is the same with iron and steel (101,000,000 francs contributed by Germany out of a total of 124,000,000 francs' worth). The organization of river transport is also responsible for the German preponderance on the Swiss market, in wool (53,000,000 francs out of a total of 73,000,000), in cotton (20,000,000 francs out of 42,000,000), and even in cereals (19,000,000 francs out of 23,000,000). Before the war the transportation of a ton of cereals cost 21.50 francs from Rotterdam to Berne as against 25.10 francs from Genoa to Berne. Of the total Swiss imports Germany furnishes one-third, of its exports it takes 22 per cent.

Except for Belgium and Holland, Rhine delta countries, and Switzerland, a country at the source of the river, it is difficult to estimate the share of foreign countries which use the Rhine for traffic or transit.

From the Rhine Italy receives coal and worked metals. To the Rhine she sends silks and cereals.

England has more evident interests. The tonnage of maritime navigation with the English ports was 68,000 in 1912. A regular steamboat service exists between Cologne and London; there is also traffic between the Rhine countries and England by way of Antwerp and Rotterdam as intermediaries. The imports of 1922 are more than those of 1913. Later the Rhine will be the natural route for the exchange of the Lorraine ores against the coking coals of England.

Finally, the United States through its cereals, petroleum, and cotton, Russia and Rumania through their petroleum and cereals, are also interested in the problems of the Rhine.

The number and diversity of the customers, the importance and weight of the transported products, more than their value, explain why the traffic of the Rhine ports rose from 25,000,000 tons in 1890 to 110,000,000 tons in 1921, i. e. twice as much as the traffic of all the rivers and canals in France during the same period.

The Rhine Ports: the River-mouth Ports

The distribution of this traffic is especially interesting. "All the Rhine ports," writes M. Gaston Haelling, "are preëminently transit ports. On the one hand, the merchandise leaves the ocean routes to change to the river route—this is the rôle of the river-mouth ports, of which Antwerp and Rotterdam are the chief; or the merchandise is transshipped to go to other ports—this is the rôle of the export ports, of which Duisburg, Ruhrort, and Cologne are the principal ones; or the merchandise is unloaded in order to continue by river route or by railroad—this is the rôle of Mannheim-Rheinau-Ludwigshafen and of Strasbourg."

Rotterdam is the only river-mouth port directly on the Rhine route. Amsterdam can be reached only by the Merwede Canal, and the passage from Antwerp to the Rhine involves the difficult crossing of Zeeland. Furthermore, while at Antwerp or at Amsterdam the direct transfer of the cargo to the barge is made only from one side of the ship, at Rotterdam it takes place simultaneously from both sides of the vessel, which is anchored in mid stream, moored to buoys or to bollards. Owing to these more advantageous arrangements Rotterdam gets the greater part of the ocean traffic destined for the Rhine. In 1913, of 14,000,000 tons going down the Rhine 7,000,000 passed through Rotterdam, and of 18,000,000 tons going up the river 15,000,000 passed through this port.

Antwerp, on the other hand, owing to the excellent network of railways which covers Belgium, is a railroad port. For this reason the Belgian ports exported only 2,900,000 tons in 1913 and imported 6,100,000 tons, principally of coal, because of the abundance of ocean tonnage used in the export trade. The excellence of the railway network limits the development of navigation at Antwerp while the really inferior arrangements of the Dutch railroads favors Rotterdam as a port. Thus Rotterdam in 1913 dispatched 131,435 tons of sugar to the Rhine while Antwerp shipped only 273 tons by the same route, not because Antwerp did not ship any sugar, but because this very expensive staple cannot stand transportation charges by rail.

As for Amsterdam, its relations with Cologne date from the period when the greater part of European traffic passed through this port. At present the difficulties of navigation in the Merwede Canal have considerably reduced this traffic. The figures for 1913 indicate only 475,000 tons coming from the Rhine and 556,000 tons going to the Rhine.

The Import Ports

The group of three ports, Mannheim-Rheinau-Ludwigshafen, owes its phenomenal development to its situation at the best point of transshipment between the sea on the one hand and South Germany and Switzerland on the other hand. Also, until recently, this nucleus was the terminus of upstream navigation. Since then Strasbourg, as is known, has assumed this rôle.[3]

Nevertheless Mannheim-Rheinau-Ludwigshafen retain all their economic importance for the exploitation of the southern markets. Indeed, even if Bavaria forms a part of the hydrographic system of the Danube, the great length of this river and its relatively poor navigability in Bavaria tie this country to the hydrographic system of the North Sea. Munich is 400 kilometers from Cassel, the terminus of navigation on the Weser, and 300 kilometers from Prague, the terminus of navigation on the Vltava (Moldau), a tributary of the Elbe. However, these places could only be reached after

[3] See the author's paper, "The Port of Strasbourg," *Geogr. Rev.*, Vol. 13, 1923, pp. 243–254.

the difficult crossing respectively of the Swabian Jura and the Bohemian Forest.

In 1913 for all three ports the traffic amounted to 8,500,000 tons incoming and 1,600,000 tons outgoing. Coal, coke, and briquettes accounted for 3,500,000 tons for Mannheim and Rheinau and 815,000 tons for Ludwigshafen. Next in amount came the cereals, 1,300,000 tons. Fuel and cereals constituted three-fourths of the incoming traffic. The remainder consisted principally of cement, iron, and steel.

Finally, attention should again be called to the considerable rôle of these three ports in the traffic of Strasbourg, which at low water is accessible for the large barges only after they have lightened a part of their cargo.

The Export Ports

The creation and expansion of the Westphalian ports are closely related to the exploitation of the coal mines. In the open lowlands of the river the dredging of large basins was easy. The basins of Ruhrort on the right bank are no less than 128 hectares in area, with 28 kilometers of docks; those of Duisburg are 42 hectares in area, with 11 kilometers of docks. These river facilities have been supplemented by the Herne Canal. It is 38 kilometers long and traverses the coal basin; 13 industrial ports discharge into it. In addition, forming part of the same group, industrial ports have developed along the Rhine. These are Rheinhausen with the Krupp factories, Homberg with the Rhein-Preussen syndicate, Alsum and Schwelgern with the Thyssen plant, and Walsum with the Gutehoffnungshütte.

The complex of these ports shipped 22,000,000 tons of coal in 1912 and received 9,000,000 tons of ore and 1,640,000 tons of earth and sand. For the nourishment of the mining population of the region these ports imported more than 1,000,000 tons of cereals. The general traffic movement reached 39,000,000 tons in 1913, thereby exceeding that of the great European ports, including London and Hamburg.

The Waterways

The Rhine

Conditions so favorable would have stimulated the development of navigation even in spite of natural obstacles. However, the Rhine is one of the rivers most favored by nature for navigation. Table I, taken from the work by Haelling, gives the principal elements of its course.

The greatest difference between the Rhine from Basel to Strasbourg and the Rhine below Strasbourg is the heavy gradient in the upstream stretch, which causes a very swift current. The mean gradient between Basel and Strasbourg is 86 centimeters per kilometer, and in the upper part of this stretch it exceeds one meter per kilometer, while in the stretch Strasbourg-Mannheim it is only 35 centimeters per kilometer (Fig 2). In addition, the improvements made below Strasbourg have increased the gradient

above that point. In the establishment of the profile of equilibrium of the river, its channel, meandering across the sands and gravels, the product of its erosion, is not fixed; furthermore, a rock ledge near Istein forms a veritable rapid. In certain places the depth of 2 meters necessary for navigation is maintained only during 45 days. Finally the average rapidity of the current in this stretch exceeds 10 kilometers an hour. As a consequence of these factors the duration of navigation is very short; a tug can haul only two barges of 5000 tons each. Traffic, therefore, is slight between Basel and Strasbourg; even in favorable years it does not amount to as much as 100,000 tons.

Table I—The Rhine: Elements in Its Navigation

Ports	Distance in Kilometers	Altitude in Meters	Average Width in Meters	Average Gradient
Basel	0	243.5	200	1:1000
Strasbourg	127	131.6	220	1:1600
Ludwigshafen	181	85.1	260	1:9000
Mainz	331	80.4	430	1:10,000
Bingen	361	76.1	250	1:2000
Coblenz	424	57.6	260	1:4000
Cologne	520	35.9	360	1:5000
Duisburg	613	20.1	380	1:5500
Rotterdam	830		500	1:8000
North Sea	860		700	

But below Strasbourg the gradient is slight and nowhere over 5 per 1000 except in the crossing of the Slate Mountains between Bingen and Bonn, where beds of quartzite cross the river and create rapids. These obstacles were removed by improvements carried out before the war. The "wilde Gefahr" of Caub is only a memory. On the other hand, the regimen of the river is very constant. The volume of water is maintained in winter by tributaries of Sequanian type (i. e. maximum volume in winter, like the Seine) and in summer by tributaries of Alpine type (maximum volume in summer).

For these reasons, navigation is very rarely interrupted on account of low water: in 1912, 9 days at Strasbourg, 6 at Mannheim, 72 at Mainz, 22 at Cologne, 16 at Emmerich. Frost has still less importance: it occurs when navigation is stopped during the low water of winter.

As a matter of fact the river, constantly being improved, has permitted regular service except for rare occasions by means of vessels of 2000 to 2500 tons between Ruhrort and Rotterdam, of 1700 to 2000 tons between Ruhrort and Mannheim, and of 1700 to 800 tons between Mannheim and Strasbourg.

The largest boat in service on the Rhine has the following measurements: length, 123 meters; width, 14 meters; draft, 2.85 meters; tonnage, 3581 tons.

Finally, the Rhine empties into a tributary sea of the Atlantic Ocean which lies at the beginning of the largest current of world commerce. This is a privileged situation as compared with the other rivers of Europe. The Danube, for instance, empties into a sea which communicates only with difficulty with the Mediterranean.

These advantages of Rhine navigation have not escaped the nations which profit by it. All have sought for easy accesses to the Rhine, i. e.

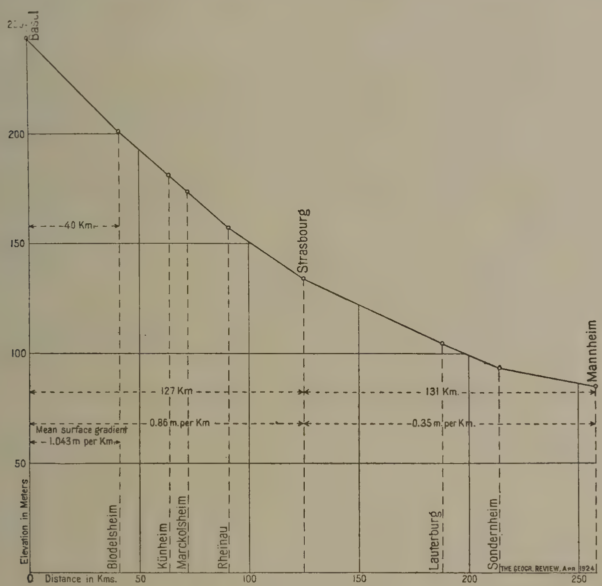

FIG. 2—Graph showing the mean surface gradient of the Rhine between Basel and Strasbourg. Based on the work by G. Haelling cited in footnote 1.

toward the sea. From this has resulted the competition among the various schemes of river and canal connections with the great river.

The Canals: Connections with the River Mouth

The central Alps give birth to three great rivers, the Danube, the Rhine, the Rhone. All three leave this common center of dispersal to reach different seas: the Black, the North Sea, and the Western Mediterranean. It is only necessary to unite these seas in order to create two uninterrupted routes going around the Alps, the one on the east and the other on the west, which shall put into communication the two great centers of European civilization, the Mediterranean and the northern seas.[4]

[4] For the canals consult Sympher: Karte der deutschen Wasserstrassen unter besonderer Berücksichtigung der Tiefen- und Schleusen-Verhältnisse, 1 : 800,000, 4th edit., Berlin, [1912?]; Carte itinéraire des voies navigables de France, 1 : 1,500,000, Ministère des Travaux Publics, Paris.

These complex relations begin at the mouth of the Rhine. For this reason the Treaty of Versailles wisely took into account the connections with ocean ports. At Pannerden immediately on its entry into Holland the great river divides into several branches which interlace with those of the Meuse. At present they are held between dikes, and the distribution of the run-off is regulated by conventions which go back to the eighteenth century. Old arms, whose width sometimes attains 100 meters, can easily be changed into canals. Also, in the great alluvial plain formed by the Meuse and Scheldt it is easy to establish connections. Amsterdam was connected with the Rhine and the Meuse by the Merwede Canal. At Antwerp starts the Scheldt-Meuse Canal, which near the Dutch-Belgian boundary joins the Zuid Willem's Canal.

Nevertheless, communication between Belgium and the Rhine is difficult. In order to increase the traffic in Ruhr coal the Treaty of Versailles has provided (Article 361) for a water route which would go directly to Ruhrort. At present the passage from Antwerp to the Rhine is 330 kilometers long. The Hentricht project, which dates from 1909 and takes up again the route proposed by Napoleon, is 185 kilometers long; it would serve the coal districts of Campine and end at Ruhrort. The Valentin project would cross the Meuse at Maastricht and end at Düsseldorf and would be 235 kilometers long. The Schneider project would cross the Meuse below Maastricht, serve the Liége industrial region, and end at Bonn and would be 320 kilometers long.

It is difficult to estimate a date at which one of these projects will be completed, but opinion is unanimous that it is necessary soon to establish a connection between Antwerp and Moerdijk (at the mouth of the Meuse) by means of an artificial channel to avoid going across Zeeland. This canal would reduce by a half the passage Antwerp-Moerdijk. It would avoid the long and dangerous passage between the islands of Zeeland, where storms are frequent.

Ruhr Canals

Belgium and Holland control the mouths of the Rhine. It is to escape this control to a certain extent that the canals between the Rhine, the Ems, and the Weser were built.

The Lippe is the principal river which drains the Ruhr district. It is canalized up to Hamm with a depth of 2.50 meters. It is connected with the Ems and the canalized Emscher by the Dortmund-Ems Canal, which was built in 1892–1899. This canal is connected with the Dutch canals about 100 kilometers south of Emden and by means of the Ems-Jade Canal with the Weser.

The Dortmund-Ems Canal is joined at Bevergern by the Herne Canal, 44 kilometers long, a section of the great Mittelland Canal which is to establish a connection between the Rhine and the Oder. At present this canal cuts the Weser at Minden and goes as far as Hanover; it is to be con-

tinued to Magdeburg and Berlin. It will make it possible for the Ruhr coal to compete in the capital of Prussia with English coal discharged at Hamburg. In 1920 the traffic of the Herne Canal amounted to 8,500,000 tons.

At present the length of the water route between Gelsenkirchen and Hamburg is 725 kilometers and between Gelsenkirchen and Bremen 280 kilometers. These distances are much too long for heavy freight. For this reason a series of canals has been projected starting from the Mittelland Canal to join the Elbe near Hamburg. But the realization of these projects may be delayed by the financial situation of Germany.

The Canalized Moselle

Westphalia in 1913 used 25,000,000 tons of Lorraine iron ore, all of which had come by rail. If the Moselle were canalized this traffic could be carried by water, with all the greater advantage because the necessary coke for the Lorraine furnaces would be carried on the return trip.

To be sure, the volume of water is not sufficient to clear away the sands that are deposited between Metz and Coblenz. The regularization of the channel is difficult, but it would be possible to turn the Moselle into a canalized river with dams and locks. A part of the expenses could be recovered by electric plants constructed along the river. Before the war projects of this nature had been studied by the German administration. It was the Westphalian industrialists who opposed these measures. Indeed, the canalization of the Moselle would have made possible cheap transportation of the coking coals and would have worked to the advantage of the Lorraine furnaces, which are situated on the ore field.

In order to favor the Ruhr industrialists the administration lowered the shipping charges by rail for Lorraine ores without correspondingly reducing the rate for coal shipped in the opposite direction.

The Rhine-Danube Connection

The connections between the Rhine and the Danube have as their object the service of the needs of South Germany and the economic conquest of the Balkan countries. It is a part of the program of Germany's orientation toward the East. The canals which, in addition to the existing connection, are to join the Rhine with the Danube are only a part of the great water route which is to connect the Black Sea with the coal basins of the Ruhr. It is at Duisburg that the cereals from the Balkans and from Hungary, the wheat and petroleum of Rumania, the wood and the ores from Central Europe are to reach their destination; it is from Duisburg that the Ruhr steel will leave to flood southeastern Europe, the shores of the Black Sea, and, beyond, the Near East. What the Bagdad Railway, stopped in its development by the war, has not been able to do, it is hoped the Rhine-Danube Canal will realize. Several projects are under consideration (Fig. 1).

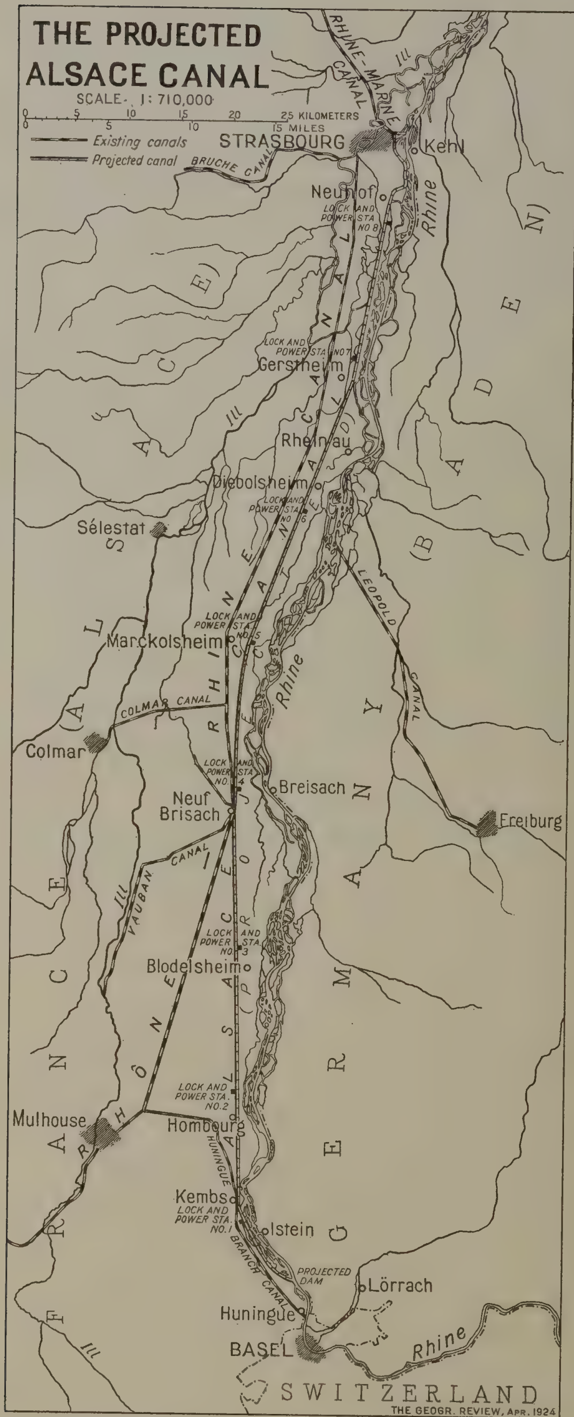

FIG. 3—Map based on the work by A. Antoine cited in footnote 1.

The first[5] involves the canalization of the Neckar as far as Plochingen above Stuttgart, then the construction of a lock canal to reach the Danube at Ulm, with a branch by way of Gmünd, Aalen, and the valley of the Brenz. The canal is sure to receive the 3,700,000 tons traffic which now goes by rail over this route; it would cross rich and densely populated districts; it would exploit the iron ore deposits, the soft coals, and limestones of the Swabian Jura. But, because of the number of engineering works to be undertaken, its cost would be high. Also, not to displease Bavaria, the Reich has preferred the second project.

This project, which between Bamberg and the Danube more or less parallels the existing Ludwig Canal, involves extending the canalization of the Main from Aschaffenburg to Wernfeld, at the northern apex of the great bend below Würzburg. From there a canal will avoid the next great bend of the river, which it will

[5] A. Ehlgötz: Die Rhein-Neckar-Donau Verbindung, *Zeitschr. für Binnen-Schiffahrt*, 1920, pp. 253–256 and 277–280.

reach again and cross at Garstadt to rejoin it at Untereuerheim and leave it finally at Bischberg after a vertical rise of 122 meters. The canal will then continue to Bamberg, follow the valley of the Regnitz, and cross the divide at Hilpoltstein at an elevation of 405 meters. It will then follow the valley of the Schwarzach, a small tributary of the Altmühl, and end in the improved Ludwig Canal. The total length of this proposed water route from Aschaffenburg to the Austrian boundary would amount to 607 kilometers, on which there would be 49 locks. It would cross the richest districts of Bavaria; its annual traffic is estimated at 10,000,000 tons; the electric power furnished by the locks is estimated at 1,000,000,000 kilowatt hours.

The Danube would be canalized from the entry into it of the canal at Kelheim to Ulm, the Lech as far as Augsburg; Munich would have a transfer port at Ingolstadt until the canalization of the Isar can be carried out. Finally, to insure a direct route to Switzerland, Germany projects a canal from the Danube to Lake Constance by way of the valleys of the Riss and Schussen.

The Alsace Canal

This last project[6] has taken form particularly since France has established herself on the left bank of the Rhine (Fig 3).

Indeed, the uncertainty of the river channel between Basel and Strasbourg, its steep gradient, and the swiftness of the current have made it necessary definitely to discard the plans which involved the regularization of the Rhine in this stretch. This undertaking, indeed, would not pay. Switzerland imports from Germany, Belgium, and Holland about 4,400,000 tons per year. To these countries it sends only 350,000 tons. The most important part of its exports consists of expensive merchandise which prefers the rail route. Barges on the river would be deprived of return freight. The commercial combination is poor.

It is therefore in the lateral plains that the solution of the problem must be sought for. Now, the Rhine flows nearer the Black Forest than the Vosges. The plain of Baden, which is relatively narrow, is blocked by the massif of the Kaiserstuhl at Breisach and, farther upstream, by the Dinkelberg plateau near Istein. Connections with the river basins are difficult on this side.

It is entirely different on the Alsatian side. The Ill traverses the plain with less gradient than the Rhine. To the south its valley ends in a large threshold, the famous Gateway of Belfort, which affords an easy passage towards the basin of the Saône. The rampart of the Vosges likewise grows lower in the north, and the Saverne threshold here affords a natural gateway which has for centuries been used by international commerce. Alsace is a country of canals.

[6] Cf. especially A. Antoine, *op. cit.*

France has received the mandate by the Treaty of Versailles to make use of these geographical advantages. A large canal paralleling the Rhine will begin on the river at Huningue and will go down to Strasbourg. The number of locks will not exceed eight. In order to furnish this canal with water, a large dam will be constructed across the Rhine near Huningue.

The current will be much less rapid than in the Rhine and will not exceed the speed of a man afoot. Instead of becoming greater in time of flood, the current, will, on the contrary, decrease, inasmuch as the whole run-off of the Rhine will be discharged into the bed of the river by the dam, which will function as an immense safety valve. At every step of this gigantic stairway an important power plant will be established. The total of these plants will make it possible to recover 700,000 h. p. This power will be made available to the industrial establishments in Strasbourg, Mulhouse, and Basel. Switzerland, too, will benefit by the Alsace canal.

THE GEOGRAPHY OF THE MOSLEMS OF THE MIDDLE AGES

By Carl Schoy

Content of Arabic Geographical Science

The majority of Arabic geographical authors based their work more or less on the "Geography" of Claudius Ptolemy. This famous Greek man of science, however, was originally an astronomer and mathematician, a circumstance not without influence upon his geographical work. To appreciate this, one need but bear in mind Ptolemy's cartographic achievements, or his division of the earth's surface into zones reckoned on the basis of astronomy, investigations of a type far removed from the work of earlier Greek scholars, who laid emphasis rather upon the describing (*γράφειν*) of lands and peoples. It thus came about that after Ptolemy the term "geography" came to be employed among the Greeks to designate primarily the exact science of the form of the earth.[1]

Quite naturally only a very few Arabic geographers were able, as Ptolemy had been, to adopt both methods as their own, the mathematical and astronomic on the one hand, the statistical and descriptive on the other. There were, rather, two groups among those Arabic scholars who contributed at all to the progress of geography: the geographers who traveled and wrote descriptive works and the astronomers. To arrive, then, at a definitive estimate of the geographical contribution of the Moslems, one would be obliged to take into consideration both types of investigation as represented by these groups, a task which the present writer believes has never been accomplished. Indeed, it scarcely could be accomplished, for many an Arabic astronomical treatise still lies buried under the dust of Oriental manuscript collections waiting to be made available by the competent hand of some future scholar. But happily the Moslems possessed one man of science who in every respect measured up to the standard of the Alexandrian Ptolemy; and about this man, the unsurpassable Abū'l Rīḥan al-Bīrūnī (973–1048), we shall be able to speak in some detail.

According to circumstances the Moslems chose as a name for geography special designations from this or that branch of geographical study: they spoke of the "Science of Roads and Countries," the "Science of Post Routes," the "Science of Longitude and Latitude," the "Science of the Peculiarities of the *Climata*,"[2] etc. An Arabic scholar himself, Ḥajji Khalfa, who died in 1658, wrote as follows in a book entitled "Discussion of the Lore of the Names of Books and Sciences:"

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[1] See the methodological and bibliographic introduction to this subject by Siegmund Günther in his "Handbuch der mathematischen Geographie," Stuttgart, 1890, p. 1.

[2] Belts running across the earth from east to west bounded by parallels of latitude.—Edit. Note.

"The Science of Geography (*jaghrāfīyā*). This is a Greek word meaning *description of the earth* (*ṣūrat al-arḍ*). It is a science through which we come to know the conditions of the seven *climata* which lie upon the inhabited quarter of the earth's surface: and besides this [it is the science] of the latitudes and longitudes of the lands which lie thereon, of the number of their cities, mountains, continents, seas, rivers, and of the other circumstances which exist upon this quarter of the earth. So it is defined in the book *Miftāḥ as-saʿāda* ("The Key of Fortune"). Sheikh Dā'ūd, however, says in his book *Tadhkira* ("Memoir") 'Geography is the science of the conditions of the [entire] earth, with reference to its division into *climata*, mountains, and rivers and of the conditions under which its inhabitants differ from one another.' This definition is the more correct, for geography deals not alone with the seven [*climata*]. Geography is a science designated by no special term in the Arabic language. The first who composed a book dealing with this science was Baṭlamyūs al-Qalauzī [Claudius Ptolemaeus]. After he had written the *Almagest* he compiled the book that is known under the title *Jaghrāfīyā*. . . . This became a standard work, consulted by every one who wrote any treatise on geography. But much that he had described fell into oblivion, his name and fame were misrepresented, and thus the gateway was closed against the uses to which one might have put his work. It was, [to be sure], translated into Arabic in the days of Ma'mūn, but at the present time this translation is not to be found."[3]

Conditions Particularly Favorable to Its Progress

The geographical horizon of the Arabs was greatly widened through the extremely rapid and victorious spread of Islam, although there had existed even in pre-Mohammedan days a certain measure of practical regional knowledge of the sort used by traders. Moslem generals were obliged as they advanced forward to collect all possible geographical data before carrying through their operations. Moreover, the central government needed descriptions of the importance, wealth, and extent of newly conquered cities and countries. According to Masʿūdī, ʿOmar, the Caliph, forwarded the following instructions in a letter to a certain man of learning: "Describe for me the lands of the earth, their climates and positions, and the influences which ground and climate exert upon their inhabitants."[4] Furthermore, the Arab conquerors for the most part found among the conquered folk a civilization far surpassing their own. They were thereby able to utilize established government postal services, well maintained roads, and registers of statistics and revenues; and the example supplied by these stimulated them in the organization of other enterprises, all of which were the products of a sort of practical geography. The language of the Koran, then as now

[3] Hans von Mžik: Ptolemaeus und die Karten der arabischen Geographen, *Mitt. K. K. Geogr. Gesell. in Wien*, Vol. 58, 1915, pp. 152–176; reference on pp. 156–157, footnote 7.

[4] C. Barbier de Meynard and Pavet de Courteille, edits.: Maçoudi, Les prairies d'or, text and French translation, 9 vols., Paris, 1861–1877; reference in Vol. 3, p. 123.

understood throughout the whole extent of the Moslem world, facilitated the journey of the Mecca pilgrim even from the farthest borderlands. According to Yāqūt, geography was a science pleasing in the eyes of God.[5] C. A. Nallino cites from Al-Ghazzālī's "Revival of the Knowledge of Religion" the following quotations illustrating this doctrine: "Whosoever goes forth from his own house in search of science will find himself until his return upon the road of God" and "for whosoever follows a highway in search of science God will render more easy the road to Paradise."[6]

Religious and astrological interests made it incumbent upon astronomers to lay particular stress upon the accurate determination of the geographical latitudes and longitudes of places. In the first place, the precise knowledge of latitudes was used in the construction of horizontal sundials (*basīṭa*), which, like town clocks, always adorned the open squares where prayers were said. Their lineation is entirely dependent upon the latitude of the town for which they were constructed. Moreover, these dials indicate the beginning and end of the noonday prayer (*ʿasr*) by the length of the shadow of the gnomon (*miqyās*), or rod. This length, however, is determined by the latitude and declination of the sun for each day.[7] Furthermore, the turning of the face toward Mecca during prayer (*qibla*) was governed by the geographical co-ordinates of Mecca and of the spot where the worshiper happened to be.[8] And finally, to cast a horoscope it was necessary to divide the heavens into twelve astrological mansions, the sizes of which were fixed by the time of year and by geographical latitude. There were reasons enough, therefore, why astronomers, who were at the same time servants of religion and readers of the stars, should wish to promote the science of the determination of geographical positions!

The Work of Travelers and Geographical Authors

Quite naturally, research and the work of translation in the West have been directed primarily to the writings of the travelers of Islam and of the geographers in the literal sense. Regional geography, hence, is the best-known aspect of Arabic geographical science. The wealth of source material, however, makes it well-nigh impossible to undertake a detailed consideration of this subject. Instead of this we can give only the following brief résumé.

The earliest Arabic geographer of repute was Muḥammad ibn Mūsā Al-Khwārizmī (died 850), who compiled a treatise entitled "Picture (Description) of the Earth" (*ṣūrat al-arḍ*) modeled closely after Ptolemy. The text accompanying the maps is extant but only in incomplete form. The

[5] C. Barbier de Meynard, edit.: Dictionnaire géographique, historique et littéraire de la Perse, Paris, 1861, p. vii.

[6] C. A. Nallino: Il valore metrico del grado di meridiano, Turin, 1893, p. 4.

[7] See Carl Schoy: Die Gnomonik der Araber, *Die Geschichte der Zeitmessung und der Uhren herausgegeben von Ernst von Bassermann-Jordan*, Vol. 1, Part F, Berlin, 1923, p. 44.

[8] See Carl Schoy: Über die Richtung der Qibla, *Sitzungsber. Bayerischen Akad. der Wiss., Math.-phys. Klasse*, Munich, 1922, pp. 55–68.

work as a whole, of which H. von Mžik gives a detailed analysis, is to be found in a single untranslated manuscript in Strasbourg.[9] In point of time there followed the official route book of Khordadhbeh, "Book of Routes and Provinces" (*Kitāb al-masālik w'al-mamālik*). Its author, an official in the central postal service at Surramanra'ā (Samarra) near Baghdad, was commissioned to undertake its compilation by the Caliph Al-Moʿtamid. The book contains accurate information about the stations, post relays, and revenues of each province. Aḥmed ibn Faḍlān was sent by the Caliph Al-Muqtadir in 921 as ambassador to the king of the Bulgars on the Volga. On his return he wrote a description of his journey.[10] Another notable geographer of this early Arabic period was Al-Maqdisī (the man of Jerusalem), who wandered through most countries of Islam, excepting Spain. In various capacities he acquired a fundamental knowledge of lands and peoples and, besides, made use of the experience and researches of his predecessors. His work, "On the Knowledge of the *Climata*," consequently presents a very valuable and full account of the Moslem world. Still another admirable treatise in the field of Arabic regional geography is the "Book of Sketches" (*Kitābal-ashkāl*) of Abū Zaid al-Balkhī (921), which underwent a first revision by Iṣṭakhrī under the title "The Routes of the Provinces" (*masālik al-mamālik*) and in turn was further revised and enlarged by Ibn Ḥauqal.[11] The sympathetic and often extremely exact understanding which the Arabic geographers had for everything foreign deserves much praise. They customarily took up in order one region after another, and one city after another, recording accurately the customs and habits of the inhabitants, something of their industrial life, and the products of the animal, vegetable, and mineral kingdoms. Besides this, they discussed every kind of superstition of which they could learn anything.[12]

As an illustration of the latter we have translated the following passage from Iṣṭakhrī dealing with ambergris.[13] "And ʿ*anbar* (*ambra* is the Spanish form) occurs in Santarem, which lies on the encircling sea, and we have heard of no place on the Mediterranean nor on the encircling ocean other than Santarem where ambergris is found, though, to be sure, during my sojourn in Syria, a little of it appeared upon the shores of the Mediterranean. Every year there goes to Santarem a crawling beast which creeps on the stones of the coast, and from him the ambergris comes. The beast is a tailless quadruped, soft as silk: its color is that of gold from which it differs not at all and its skin is a costly treasure. The pelts are collected and made

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[9] Hans von Mžik, *op. cit.*, pp. 159–165.

[10] See C. M. Fraehn: Ibn Fosslan und anderer arabischer Berichte über die Russen älterer Zeit, St. Petersburg, 1823.

[11] The famous Dutch Orientalist, M. J. De Goeje, has edited the text of this together with many other Arabic geographical texts in the Bibliotheca geographorum Arabicorum, in 6 volumes, Leiden, 1870–1894. See also De Goeje's Selections from Arabic Geographical Literature in R. J. H. Gottheil and Morris Jastrow's *Semitic Study Series*, No. 8, Leiden, 1907.

[12] See the description of the *ghūl*, or ghost of the desert, according to various Arabic geographers in Bernhard Moritz: Arabien: Studien zur physikalischen und historischen Geographie des Landes, Hanover, 1923, p. 8. Iṣṭakhrī branded this superstition as ridiculous.

[13] De Goeje, Bibliotheca, Part I, p. 42.

into garments which in the daytime display most varied colors, and the kings of the Omayad dynasty forbid (monopolize) their use. They are exported only in secret, a fact which raises the cost of the garments to some 1000 dinars because of their rarity and beauty."[14]

A most meritorious Arabic geographer was Masʿūdī (died 956), after Ibn Baṭūṭa the greatest traveler of the age. His travels are recorded in the "Meadows of Gold" (*Murūj adh-dhahab*)[15] and have been preserved. Like Iṣṭakhrī and Ibn Hauqal, he visited, among other parts of the world, the Volga region and corrected the ancient mistake that the Sea of Azov is connected with the Caspian, though, for all that, he argued that the Volga divides its waters, sending a branch to each sea. Masʿūdī also made a thoroughgoing study of geographical literature and worked into his writings many details from older works that have not been preserved.[16]

An altogether exceptionally prominent place among Moslem scholars was held by Al-Bīrūnī. His labors as mathematician, astronomer, and geographer were of uniformly excellent quality. At first in the service of the lord of Khiva, he later entered the employ of the two rulers of Ghazna in Afghanistan, Maḥmūd and Masʿūd. The high esteem which he enjoyed is proved by the statement of the former: "Science is so sublime that it cannot be surpassed. To it come all mortals, but it comes not to mortals." Al-Bīrūnī's devotion to learning was so unparalleled that it was said of him: "His hand scarcely ever left the scroll, nor his eyes ceased observing and his heart pondering except on the two days, Nairūz and Mihragān" (Persian holidays in spring and autumn). With his last patron Al-Bīrūnī went to India, learned the Indian tongue and sciences, and in exchange taught those of the Greeks. The fruit left for posterity of his Indian journeys and studies was the famous description of India,[17] a work which, by reason of Al-Bīrūnī's universal comprehension and profound knowledge of facts, may be regarded as the most significant Arabic production in the field of regional geography.

A geographical document, also of high importance, is the "Roger Book" (*Kitāb Rojēr*) of Idrīsī (1099–1164), a description of the earth with seventy maps compiled for King Roger II of Sicily. In this the seven *climata*, or geographical provinces, are set forth.[18]

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[14] See Hermann Ethé: Morgenländische Studien, Leipzig, 1870, p. 167–173; J. Ruska's article, Anbar, in *The Encyclopaedia of Islam*, Leiden and London, 1913, Vol. 1, p. 347; and finally the excellent dissertation of Fr. Storbeck: Die Berichte der arabischen Geographen des Mittelalters über Ostafrika (Zenj), Tübingen, 1912, pp. 67 ff.

[15] See above, footnote 4.

[16] See also his "Book of Admonishment and of the Revision" (*Kitāb at-tanbīh w'al-ishrāf*), translated by Bernard Carra de Vaux into French, "Maçoudi: Le livre de l'avertissement et de la révision," Paris, 1897.

[17] Translated into English by Eduard Sachau under the title "Alberuni's India" (Trübner's Oriental Series), 2 vols., London, 1888.

[18] A complete, though insufficient, translation of the "Roger Book" was published by Amédée Jaubert: Géographie d'Édrisi, traduite de l'arabe en français, *Recueil de voyages et de mémoires publié par la Société de Géographie*, Vols. 5 and 6, Paris, 1836, 1840. We owe to R. Dozy and M. J. De Goeje a critical edition of the section dealing with Spain and Africa: Description de l'Afrique et de l'Espagne par Edrīsī, Leiden, 1866 (Arabic text with French translation and notes).

A geographical dictionary based upon valuable sources and numerous personal journeys was left for us by the scholar Yāqūt (1179–1229), a man upon whom life bestowed only poverty and hardships. As a boy Yāqūt became a prisoner and was bought as a slave by a merchant of Baghdad.[19] His dictionary is entitled "The Totality of Cities (Lands)" (*Muʿjam al-buldān*).[20]

The fame and works of Dimishqī,[21] Abū'l-Fidā',[22] and Ibn Baṭūṭa[23] are so well known that a mere mention of them must suffice.[24]

Arabic Cartography

One might expect that the Arabic scholars trained in astronomy would have taken over and developed the cartography whch Ptolemy bequeathed to them. This, however, was by no means the case. They contented themselves in their works on astronomical tables (*zījāt*) with a bald tabulation of cities and regions according to latitude and longitude.[25] At all events Al-Khwārizmī, whose "Kitāb ṣūrat al-arḍ" was assuredly nothing but the text accompanying his map of the world, took no heed of any grid of co-ordinates. His map, which exists at the present time only in incomplete form, was apparently copied from a Syrian copy of the world map of Ptolemy.[26]

Idrīsī's map of the world, of which the "Kitāb Rojēr" also seems to have formed an explanatory text, reveals an even further retrogression in Arabic cartography. Preserved in several specimens, it surprises the student by the care here and there revealed in its draftsmanship. Nevertheless, with Idrīsī all understanding of geographical co-ordinates had completely disappeared, and the same may be said of any understanding of scale. Iṣṭakhrī's map of Persia is likewise nothing but a rough sketch.

Recently Hans von Mžik has made known a seventeenth century Persian manuscript of the "Kitāb ṣūrat al-arḍ."[27] Of the maps which accompany

[19] Further details in regard to Yāqūt's life are to be found in Carl Brockelmann: Geschichte der arabischen Litteratur (2 vols., Weimar, 1897–1902), Vol. 1, pp. 479–480.

[20] Edited by F. Wüstenfeld, 6 vols., Leipzig, 1866–1873. A second geographical dictionary entitled "The Book of Synonyms" (*Al-mushtarik*) was also edited in Arabic by F. Wüstenfeld.

[21] A. F. Mehren, edit.: Cosmographie de Chems-ed-Din Abou Abdallah Mohammed ed-Dimichqui. Texte arabe, publié d'après l'édition commencée par M. Fraehn, St. Petersburg, 1866. Translated, Copenhagen, 1874.

[22] J. T. Reinaud and Stanislas Guyard, edits.: Geographie d'Aboulféda, traduite de l'arabe en français, 2 vols. in 3, Paris, 1848, 1883.

[23] C. Defrémery and B. R. Sanguinetti, edits.: Voyages d'Ibn Batoutah, *Collection publiée par la Société Asiatique*, 4 vols., Paris, 1874–1879. See also Hans von Mžik's more recent edition of the journeys of Ibn Baṭūṭa through India and China: Die Reise des Arabers Ibn Baṭûṭa durch Indien und China (14. Jahrhundert), *Bibliothek denkwürdiger Reisen*, Vol. 5, Hamburg, 1911.

[24] See the chapter entitled "Merits of the Arabic Geographers" (*Vorzüge der arabischen Geographen*) in O. Peschel's "Geschichte der Erdkunde," 2nd edit., edited by Sophus Ruge, Munich, 1877, pp. 158–160.

[25] From such tables of geographical co-ordinates, Joachim Lelewel in the Atlas accompanying his "Géographie du moyen âge," Brussels, 1849, constructed maps on the equidistant cylindrical projection (*Plattkarten*) of a sort never found in Arabic cartography. In this he was followed by Heinrich Haag: Die Geschichte des Nullmeridians, Leipzig, 1913.

[26] The world map must be reconstructed from the text of the "Kitāb ṣūrat al-arḍ." Four detailed maps, however, accompany the manuscript. These are reproduced, together with some specimens of maps of Iṣṭakhrī and Idrīsī, in the article of Hans von Mžik referred to in footnote 3, above.—Edit. Note.

[27] Das "Buch der Abbildung der Länder," Handschrift der Hofbibliothek in Wien, *Mitt. Geogr. Gesell. in Wien*, Vol. 62, 1919, pp. 145–149.

this he writes: "To dispose of them with the bald judgment that they are cartographic barbarisms would be unjustifiable, even though they are completely lacking in everything we regard as requisite for maps and even though we can hardly imagine practical uses to which such productions might possibly have been put. Perhaps we are altogether mistaken in speaking at all of practical uses in this connection, so predominatingly are all the details subordinated to ornamental execution. This is done through the subdivision of the material upon the space to be covered and through the use of colors. Just as the Orientals use writing as ornamentation and in doing so subordinate the literary content of the text to decorative purposes, so here an attempt was made to reach the same result with the means of expression furnished by cartography. The attempt was somewhat primitive, possibly executed without deliberate intent or in a playful spirit, but, for all that, original."[28]

Arabic nautical science has received as yet but little attention. Vasco da Gama seems to have seen a sea chart in the hands of an Arab pilot and to have admired the cylindrical projection upon which it was drawn.[29] Several extant Arabic pilot manuals refer to the actual existence of sea charts, although up to the present time none of the latter have come to light. The manual for the Indian Ocean, the "Book of the Uses of the Principles of Navigation" (*Kitāb al-fawā'id uṣūl ʿilm al-baḥr*) of Shihāb ed-dīn Aḥmed ibn Mājid (1490) has recently been edited from a manuscript of the Bibliothèque Nationale in Paris.[30] The manuscript, however, does not seem to contain charts. This much, however, appears certain, that the first scientific principles of navigation did not originate in Europe with the Portuguese but, like so many other things, were first formulated in the Orient. Siegmund Günther was of the opinion that Moslem navigators used an instrument called *al-kāmil* (the whole, the complete) for determining positions.[31]

Determination of Longitudes and Latitudes of Countries and Cities

As has already been hinted, the determination of latitude and of longitude among the Moslems was a problem for astronomers. In computing longitude they began, either, as the Greeks had done, in the farthest west and counted thence eastward through the 180 degrees of the οἰκουμένη (known world) or else they reckoned east and west for a distance of 90 degrees on either side of a fictitious central meridian passing through the "Cupola of the World" (*Qubbat al-arḍ*) or the "Cupola of Arīn" (*Qubbat-Arīn*),

[28] *Ibid.*, p. 148.

[29] Peschel, *op. cit.*, p. 146.

[30] Gabriel Ferrand, edit.: Livre des renseignements utiles sur les bases et les principes de la science nautique, *Journ. asiatique*, 1918, 1922.

[31] See Siegmund Günther: Die indirekten Ortsbestimmungsmethoden in der Entwicklung der mathematischen Geographie, *Sitzungsber. Bayerischen Akad. der Wiss., Math.-phys. Klasse*, 1919, pp. 299-351, and the critical review of this monograph by the present writer in *Mitt. zur Geschichte der Medicin und der Naturwissenschaften*, Vol. 19, No. 5, pp. 252 ff.

which lay at the center of the earth's surface on the equator. The word *Arīn* is an erroneous transcription of the Greek *'Οζήνη*, which in turn represented the Indian *Uzain*. Though only a few astronomers reckoned from the meridian of Arīn, its accurate identification has brought forth a small literature.[32]

When the Moslems made use of eclipses of the moon to find the difference in longitude between two stations, their results were often inaccurate to the extent of several degrees. This, however, was the method almost always employed by them. Only once, so far as we know, has there come to light a description of a so-called terrestrial calculation of longitudes—in the writings of Al-Bīrūnī. Having determined accurately the shortest linear distance between two points and the latitudes of each, Al-Bīrūnī calculated the difference in longitude from the data thus acquired. This he did in correcting older figures for the distance in longitude between Alexandria and Ghazna, together with the longitudes of a number of intermediate points. This calculation is discussed in a chapter of his famous astronomical geography, "Qānūn Masʿūdī," a work comparable to the "Almagest" of Ptolemy, though unfortunately still entirely unavailable for the use of students. The present writer, however, has published a German translation of the interesting chapter in question with a commentary.[33] In this connection Al-Bīrūnī set himself the question, "May longitudes be found better by calculating terrestrial distances than through the observation of eclipses?" His answer is as follows:

"If you have found the distance so accurately that you may substitute for it a straight line with a great approach to the truth, the advantage lies with this [the terrestrial] method. The determination of longitudes from eclipses is difficult because both the exact moment of the beginning as well as of the end of an eclipse may be determined only approximately, since (the beginning and the end of the eclipse) is preceded by the contact of two shadow circles. And the moon darkens herself so that her darkened color resembles the smoke of a light in the hand. The contact is delayed in exactly the same way at the departure of the two circles in the course of its (the contact's) disappearance. Then, the circular outline of the shadow is not clear except after one has taken it to a certain extent from the moon according to agreement (Sodann ist der kreisförmige Umriss des Schattens nicht deutlich, ausser man ihn vom Monde etwas nach Übereinkunft genommen hat). In this interval the moon moves farther according to equinoctial time. That which produces gaps in the longitude through addition or subtraction is often to be attributed to the fact that an interval intervenes in the observation, in case the two observers have not come to a previous agreement to serve themselves with their sight and skill according to a formulated plan, and one of them should not go by a river and

[32] See Carl Schoy: Längenbestimmung und Zentralmeridian bei den älteren Völkern, *Mitt. K. K. Geogr. Gesell. in Wien,* Vol. 58, 1915, pp. 27–62.

[33] Carl Schoy: Aus der astronomischen Geographie von Araber: Originalstudien aus al-Qānūn al-Masʿūdī des arabischen Astronomen Muḥ. b. Aḥmed Abū'l-Rīḥān al-Bīrūnī (973–1048), *Isis,* Vol. 5, 1923, pp. 51–74.

the other to the sea."[34] The difference in longitude (24⅓°) between Baghdad and Ghazna found by Al-Bīrūnī by means of the terrestrial method is remarkably accurate.

The technical procedure of the Arabic astronomers in determining longitude by observing eclipses of the moon is clearly explained by the Fatimid astronomer, Ibn Yūnus (died 1009 in Cairo), a man preëminent both in practical and theoretical work and author of the famous Hakimite Tables. The author says:[35] "In the determination of the difference in longitude between two places from an eclipse of the moon it is necessary that for the measurement one be equipped with two very accurate instruments which have been tested by two men of learning and experience: for experience in mensuration is of the greatest importance. In case the two men should have little experience, calculate the number of days which still precede the eclipse: then let the two measure some fixed stars (their altitudes) until the eclipse takes place, and in this way they will have acquired some practice. It is also necessary that the two know accurately the place where the earth's shadow enters upon the edge of the moon's disk in order that the gaze may be directed unflinchingly at the place of contact, and thus the measurement of ells serves the understanding of the eclipse. I have already explained when discussing the calculation of eclipses how one recognizes the place of the first contact. And in regard to that which lies between the two moments of this contact and the instant when the eclipse becomes evident certain of the earlier [astronomers] (predecessors) have said that in the interval between these two moments 1°49′ of the equator turns and this makes 7 minutes 16 seconds of equivalent time. And the matter stands with me almost as mentioned. And now when each of the two has surely (indubitably) noted the eclipse with his eyes, then let him take the altitudes of several fixed stars. Then let each of them reckon from the momentary place of the star and its latitude its [the star's] distance from the celestial equator and likewise the half of its arc which it traverses over the earth, then the variation (3rd inequality) of the moon,[36] furthermore the right ascension of the degree with which it goes through the nona-

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[34] This passage and the following passage from Ibn Yūnus have been rendered literally from Dr. Schoy's German translation at the expense of style and clarity in order that there may be the least possible departure from the meaning of the Arabic original. Dr. Schoy describes (*op. cit.*, p. 64, note 2) the passage from Al-Bīrūnī as "etwas knappen und nicht ganz deutlich" (somewhat brief and not altogether clear). The translation as prepared for the *Geographical Review* differs slightly from the form in which it appears in *Isis* (*loc. cit.*).—Edit. Note.

[35] Arab MS., Leiden, No. 143, p. 80. On the English translation of this passage see the preceding note. Phrases and words inserted by Dr. Schoy in elucidation of the text are given in parentheses. The passage was submitted to Dr. W. Carl Rufus of the Detroit Observatory, University of Michigan, Ann Arbor, Mich., who was kind enough to supply the diagram Figure 1 on the following page and the explanation of the passage beneath the diagram. Phrases and words inserted by Dr. Rufus and by the editor of the *Geographical Review* are placed in square brackets.—Edit. Note.

[36] In the manuscript as originally submitted by Dr. Schoy, instead of "the variation (3rd inequality) of the moon," was the phrase: "the difference of culmination (of the passage) of the star (?)." Subsequently, in a letter to the editor of the *Review*, Dr. Schoy suggested that the passage be changed so as to stand as given in the text. Dr. Rufus, however (see preceding footnote), believes that the passage may be interpreted more readily if Dr. Schoy's original reading be retained.—Edit. Note.

gesimus (highest point of the ecliptic, middle of the heavens[37]), likewise the right ascension of the degree which rises with it, and also that part of its arc which has swung above the horizon calculated from the rising to the time of the observation (the *Dā'ir*). Now add to this arc the right ascension

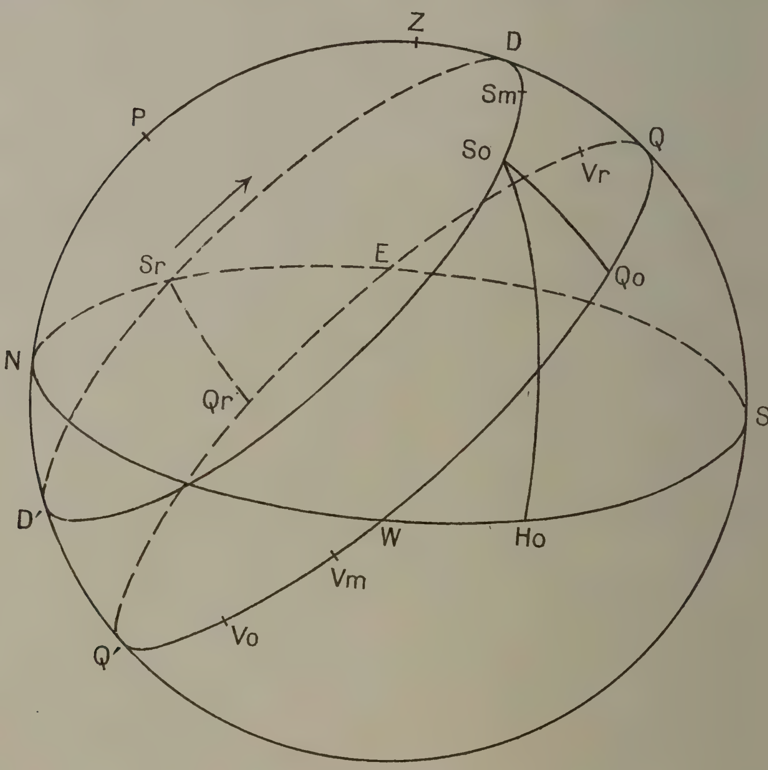

FIG. 1—The circle represents the celestial meridian. NESW is the horizon. QQ′, the equator. DD′, the star's declination circle. Sr, Sm, So, the star at rising, on the meridian, and at the time of observation. Vr, Vm, Vo, the vernal equinox at the same instants.

HoSo, the altitude of the star.

The latitude of the star is not given, as the ecliptic is omitted from the diagram.

QoSo, the star's "distance from the celestial equator," i. e. its declination.

SrD, half of the arc which the star "traverses over the earth," i. e. half its diurnal arc.

QrE, "the difference of culmination (of the passage) of the star" (see footnote 36), which is the difference between the right ascension of the star and the right ascension of the point of the equator which rises with it.

VmQ, "the right ascension of the degree with which it goes through the nonagesimus," (the meridian, see footnote 37). This is the star's right ascension, which is given also by VrQr and by VoQo.

VrE, "the right ascension of the degree which rises with it."

SrDSo, "that part of its arc which has swung above the horizon calculated from the rising to the time of observation." An equivalent arc on the equator is VrQVo.

VoQE, the sum of the two preceding arcs, which is the right ascension of the rising point on the equator at the time of the observation. Hence the correction suggested in footnote 38.

VoQ, the right ascension of the nonagesimus (the meridian), which is local sidereal time expressed in degrees. The difference between the local sidereal times at two points gives the longitude.

[37] Dr. Rufus would substitute "meridian" for "highest point of the ecliptic."—EDIT. NOTE.

of the degree which rises with it; what results is the right ascension of the rising (star)[38] at exactly this moment. We subtract 90° from it, and in case it [the right ascension] is less than 90° we augment it by 270°; that which then results is the right ascension of the degree of the nonagesimus [local sidereal time]. We take the difference between the former and the latter right ascensions (of the nonagesimus, yielded by each single calculation of the two observers in the two places whose difference in longitude was sought): it is equal to the difference in longitude between the two places."

One result of outstanding importance that emerged from Arabic determinations of longitudes was the correction by shortening some 17° of Ptolemy's exaggerated figure for the length of the Mediterranean Sea.[39]

Various Arabic geographers carried out unusually thorough researches leading to the determination of geographical latitudes and thereby contrived methods as original as the results occasionally were accurate. This chapter in the history of Arabic astronomy contradicts the oft-made assertion that Moslem astronomers in no way surpassed the "Almagest" of Ptolemy.

The astronomers of the early Arabic period such as Al-Khwārizmī, Al-Ferghānī, Ḥabash al-Ḥāsib, and Al-Battānī made use primarily of Greek and Indian methods of finding latitude. Greek, for instance, is the reckoning of geographical latitude, ϕ, from the difference between the duration of the longest day and of the equinoctial day at a given station; Indian, the measurement of the meridian altitude of the sun, H, on an equinoctial day so that $H=90°-\phi$, or, in case one prefers to take the sun's declination, δ, $H=90°-\phi+\delta$, whence the required ϕ is directly found. In treatises as early as those of Al-Khwārizmī and Al-Battānī one comes across directions for ascertaining the altitude of the pole (latitude) as the mean between the upper and lower altitudes of culmination of a circumpolar star ($\phi=\frac{h1+h2}{2}$). There has, however, nowhere come to light an example of the actual application of this method expressed in figures, and hence the student is obliged to conclude that the Moslems never put it to practical use. Between the instants of culmination of such stars there intervenes an interval of twelve hours, but in the subtropical regions of Islam night does not last much more than twelve hours. Indeed, it is not impossible that these passages in the texts of Al-Khwārizmī and Al-Battānī are either unauthentic or else were bodily interpolated by a later editor or copyist. How this method was altered so that it might be given practical application has been ascertained by the present writer from a brief account given by Al-Bīrūnī in his "Qānūn al-Masʿūdī." After first treating the manner of finding latitude by the culmination altitudes of a circumpolar star, the astronomer suggests that this method may be applied to the sun, observing that the

[38] Instead of "star" Dr. Rufus believes that "degree" or "point on the equator" should be substituted here.—EDIT. NOTE.

[39] Further details regarding this will be found in L. P. E. A. Sédillot: Mémoire sur les systèmes géographiques des Grecs et des Arabes, Paris, 1842.

mean of the sun's greatest meridian altitude at the beginning of Cancer and of its least at the beginning of Capricorn are equivalent to its equinoctial altitude at the point of observation. In this manner Al-Bīrūnī found the latitude of his dwelling place, Ghazna, to be 33° 35′, certainly an accurate figure. Furthermore, he pointed out that this calculation might be made by referring the sun's altitude to two constellations both the same astronomical distance from the two solsticial constellations, Cancer and Capricorn, and he cited Leo and Sagittarius as examples of constellations particularly well adapted for this purpose. Besides these methods, Al-Bīrūnī knew of a number of other ways of determining latitude, but space will not permit their discussion in the present paper.

Equally individual methods were employed by Ibn Yūnus for ascertaining accurately the latitude of his point of observation, Fosṭāṭ (old Cairo). We mention only the ingenious procedure of finding latitude at the time of the summer solstice from the height of the sun in the east-west circle (1 vertical),[40] according to which Ibn Yūnus placed Fosṭāṭ in latitude 30° N.. This figure served to correct figures given by other scholars, among them Abū'l Faraj, known as Ibn aṭ-Ṭaḥḥān (the miller's son), who had asserted that his observations with a sundial set up in Al-Qarāfa had given a latitude of 29° N.

Another very well known Arabic man of science, Ibn al-Haitham (965–1038), the Alhazen of the Occident, devoted a separate work to the exact calculation of latitudes. He recommended taking a bright fixed star for the precise determination of the altitude of the pole, a star which in its upper culmination reaches the zenith or at least comes very close to the zenith. Then, very near the zenith two so-called corresponding altitudes to the east and west of the star shall be taken with the astrolabe. In this way Ibn al-Haitham would eliminate the influence of refraction, known markedly to affect the measured altitudes of stars at greater distances from the zenith. The time which elapsed between the moment the fixed star left its eastern altitude and the moment when, having passed through the zenith or through its maximum altitude, it reached its western altitude, was to be measured as accurately as possible with a water clock. When the two observed heights, the interval between the observations, and, in case the star did not culminate in the zenith, the altitude of its culmination had all been measured, one could calculate the latitude of the place of observation.[41] Ibn al-Haitham gives no illustration of the use of this method in which figures are quoted.

It is possible, however, to cite certain numerical results testifying to the excellence of Arabic determinations of latitude. The sons of Mūsā ben Shākir found, for the latitude of the Bāb aṭ-Ṭāq (Gate of the Arch) at Baghdad, 33° 20′ N.—a figure accurate within a minute. Al-Māhānī

[40] These experiments of Ibn Yūnus and others are discussed by Carl Schoy in *Annal. der Hydrogr. und Marit. Meteorol.*, Vol. 49, 1921, pp. 124–133; Vol. 50, 1922, pp. 3–20.

[41] German translation of this text with commentary is given by Carl Schoy in *De Zee*, No. 10, 1920, pp. 586–601.

found the latitude of Surramanra'ā to be 34° 12′ N., the true figure, according to M. von Oppenheim,[42] being 34° 11′ 50″ N. Similarly the Tatar astronomer Ulugh Beg (died 1449) determined the latitude of the observatory of Samarkand to be 39° 37′ N., corrected by Struve to 39° 38′ 50″ N.

Naturally more inexact figures are also to be found in Arabic astronomical treatises. When latitude was reckoned from the shadow of the gnomon, errors of as much as 15′ crept in, because these shadows were cast from the upper edge of the sun and not from its central point. Ibn Yūnus first called attention to this source of error.[43]

The Size and Shape of the Earth

Divers Moslem authors described the measurement of the earth carried out on the order of the Caliph Al-Ma'mūn in the desert of Sinjar. This gave a terrestrial degree of 56⅔ Arabic miles,[44] a figure accepted by the majority of the Arabic men of science. Besides this we know also of a measurement of a degree which Al-Bīrūnī carried out for himself. This is thoroughly described in the "Qānūn al-Masʿūdī" (Part V, Ch. 7), where it is stated that Al-Bīrūnī had a highly reliable assistant measure a part of a terrestrial degree in the northern part of Dehistān in the territory of Jorjān and that he later carried this problem to completion in India by measuring the so-called horizontal depression from a mountain 652.05 ells in height. The result was 56 miles, 0′ 50″ 6‴. It is known that these miles each contained 4000 black ells, a measure concerning the exact length of which we are not altogether clear, though it cannot have been far from ½ meter. Al-Bīrūnī adds that this black ell was used in measuring houses and courts in Baghdad, and one may be permitted to suppose that it is still determinable there.[45]

In concluding, to touch for a moment upon the problem of the shape of the earth, we find that the majority of Arabic scholars held that the earth is a sphere floating in space, although there were varying opinions upon this subject in different schools. There is a summary collection of these opinions in the "Work of Costly Treasures" of Ibn Rusteh (about 900), translated into German by Wiedemann.[46]

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[42] Max von Oppenheim: Vom Mittelmeer zum Persischen Golf, Vol. 2, Berlin, 1900, p. 221.

[43] See *Annal. der Hydrogr. und Marit. Meteorol.*, Vol. 49, 1921, p. 131.

[44] Mean value of several somewhat divergent figures.

[45] The following special monographs deal with Arabic measurements of a degree: Eilhard Wiedemann: Über die Dimensionen der Erde nach muslimischen Gelehrten, *Archiv für die Geschichte der Naturwissenschaften und der Technik*, 1912, pp. 250–255; Carl Schoy: Erdmessungen bei den Arabern, *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1917, pp. 431–445.

[46] Eilhard Wiedemann: Anschauung der Muslime über die Gestalt der Erde, *Archiv für die Geschichte der Naturwissenschaften und der Technik*, 1909, pp. 310–319.

TERRITORIAL REORGANIZATION IN EUROPEAN RUSSIA

NOTES ON THE POLITICAL MAP

Since the World War the chaotic political and economic situation in Eastern Europe has produced frequent changes of boundaries both provincial and national. These changes have not been altogether ephemeral or arbitrary. Many have been determined by relatively permanent geographical factors, and many may be expected to last. Something of the geographical background for understanding the changes may be gained from a recent concise and clearly written regional geography of Eastern Europe by Walther Tuckermann.[1] Within Russia a thoroughgoing territorial reorganization was given recognition by the Soviet government in the autumn of 1921. The boundaries of various so-called autonomous provinces and independent and autonomous republics which had emerged during the Revolution were then determined by decree. The ostensible purpose was decentralization, the concentration of local government in the hands of the divers peoples of Russia. The "republics" and "autonomous provinces" represent ethnic groups which have been established for centuries on Russian soil. The new political map of Russia, consequently, is more or less an ethnographical map as well. This becomes evident when we compare on Figure 1 the boundaries of the autonomous and independent republics and autonomous provinces[2] with the areas occupied by the principal races of European Russia.

For the sake of simplicity we may divide the principal ethnic stocks of European Russia into six groups: Russian, Finnish, Turko-Tatar, mixed stocks of the Caucasus, Kalmuck, German. Besides these there is a scattering population of Jews, Rumanians, Greeks, and others, not represented by territorial autonomy.

1. The dominant Russian stock is divided into three main branches, Great Russian, White Russian, and Little Russian. The Russian Socialist Soviet Republic proper (1),[3] with Moscow as its capital, comprises Great Russia, the old nucleus of the Empire, together with the regions settled by Great Russians. Only four of the administrative provinces into which this

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[1] Walther Tuckermann: Osteuropa. 2 vols., 116 and 124 pp.; maps, ills., bibliogrs., indexes. (Jedermanns Bücherei.) Ferdinand Hirt, Breslau, 1922.

[2] These boundaries are based essentially upon an official map published at Moscow in 1921, for a discussion of which see P. Camena d'Almeida: Une nouvelle carte politique de la Russie d'Europe, *Ann. de Géogr.*, Vol. 32, 1923, pp. 75–79. Plates 138 and 139 of the eighth edition of Andrees Handatlas, 1922, indicate the new political divisions of Russia, including the new provinces of Soviet Russia proper. See also "Artarias Karte der Russischen sozialistischen föderativen Sowjet-Republik," 1 : 6,000,000, Vienna, 1922 (?) and B. Adler: Übersichtskarte des Bundes der Sozialistischen Sowjet Republiken, S. S. S. R. (Europäisches Russland) 1:6,500,000, Verlag "Kniga," Berlin, 1923.

[3] Numbers in parenthesis refer to the numbers on Figure 1.

FIG. 1—Map showing the administrative divisions of European Russia, and in relation, the principal ethnic groups. The numbers refer to the following administrative divisions: 1, Great Russia: Russian Socialist Soviet Republic (43 governments); 2, Republic of Ukraine (12 governments); 3, Republic of White Russia; 4, Workers' Community of the Carelians; 5, Autonomous Province of the Zyryans; 6, Autonomous Province of the Votyaks; 7, Autonomous Province of the Cheremisses; 8, Autonomous Province of the Chuvashes; 9, Tatar Republic of Crimea; 10, Tatar Republic of the Middle Volga; 11, Bashkir Republic; 12, Kalmuck Republic; 13, Republic of Georgia; 14, Republic of Armenia; 15, Republic of Azerbaijan; 16, Republic of Abkhazia; 17, Republic of the Kabards; 18, Republic of the Mountaineers; 19, Republic of Daghestan; 20, Autonomous Province of the Karachaevo-Cherkesses; 21, Autonomous Provincee of the Chechenzes 22, Autonomous Province of Nakhichevan; 23, Workers' Community of the Germans.

republic is subdivided retain the same territorial areas as those of the "governments" of the Tsarist régime. In the majority of cases the old divisions have been split up and rearranged. The original partitioning of the Empire into governments and provinces had been made with a view toward approximating equality in the population of each. This resulted in wide differences of area, from the immense, remote, and unsettled Archangel and Vologda governments to the smaller, more thickly populated governments of central Russia. The Soviet policy has been to increase the total number of subdivisions and to split up the larger districts.[4]

Clustering about the borderlands of the Russian Soviet Republic proper and forming enclaves within its territory are the various united republics and provinces. On the southeast two republics represent the two lesser branches of the Russian stock. The largest of these, that of the Ukraine (2), occupies the upland steppes between the Dniester and the Dnieper and the broad plain east of the latter river. North of the Ukraine the small republic of White Russia (3) lies along the Polish border south and east of Minsk.

2. Finnish folk, widely dispersed through the forests of the north, were granted the status of autonomy in five areas: The Workers' Community of the Carelians (4) between Lakes Ladoga and Onega and the shores of the White Sea; the extensive autonomous province of the Zyryans (5) in the far northeast; the smaller autonomous provinces of the Votyaks (6) and Cheremisses (7) in the borderlands of the forest northeast and northwest of Kazan; and the mixed Turko-Finnish province of the Chuvashes (8) west of the Volga near Kazan.

3. Moslem Turko-Tatar stocks, coming originally from Central Asia, have kept to the steppe country of the south. These once nomadic peoples are represented in the Tatar Republic of the Crimea (9), occupying the interior of the Crimean peninsula, in the Tatar Republic of the Middle Volga (10), lying about Kazan and to the eastward, and in the Bashkir Republic (11) of the southern Urals.

4. The Buddhist Mongol Kalmucks comprise a republic (12) situated in the semidesert plains southwest of the lower Volga.

5. The complex of small states of the Caucasus, of Transcaucasia, and of the plains to the north reflect the ethnographical mingling of this region, racially one of the most confused in the world. Three states, however, are of primary importance: the Republics of Georgia (13) and of Armenia (14), composed mainly of Christians, and, to the east, occupying the lower Kur valley, the Moslem Tatar Republic of Azerbaijan (15). To the north lie the four small predominantly Moslem republics of Abkhazia (16), of the Kabards (17), of the Mountaineers (18), and of Daghestan (19) and the autonomous province of the Karachaevo-Cherkesses (20). A small portion of the last-named (not shown on the map) was detached early in 1922 to form a new province of the Cherkesses. The eastern portion of the Moun-

[4] For an analysis of these changes, see *Weltwirtschaft und Statistik*, Vol. 2, 1922, pp. 482–483.

taineers' Republic has also recently been constituted as the autonomous province of the Chechenzes (21). South of Armenia, in the upper valley of the Araxes, is the Moslem autonomous province of Nakhichevan (22).[5]

6. Finally mention must be made of the isolated German settlements planted in the eighteenth century along the Volga in the neighborhood of Saratov. Out of these there has been constituted a Workers' Community of the Germans (23), whose capital, Marxstadt, is the older Ekaterinstadt, named from Catherine the Great. M. Camena d'Almeida remarks[6] that, though these Germans have preserved their language and religion, the influence of physical environment has been so potent that one can scarcely distinguish externally a German of the Volga from a Great Russian.

Recent reports show that, though at first nominally "independent" or "autonomous," the various republics and provinces in reality are entirely subject to Moscow. However, constituted as they were during a time of political anarchy, they may be taken to represent areas into which Russia would tend naturally to split, were the central authority removed or materially weakened. The aim of the central authority during the last two years has been towards further political centralization. By 1923 the autonomy of the Ukraine, and, we may presume of the other states, had been largely done away with. As a measure of suppressing the federal character of Russia the name of the body politic as a whole has been changed from "Russian Federated Socialist Soviet Republic" to "Union of the Russian Soviet Socialist Republics."

A further reorganization of European Russia into twelve "economic regions" was proposed in 1922.[7] Each region was to represent a territorial economic unit, "susceptible of fulfilling one or another function in the general economic dynamics of the country." To the authorities of each was to be left broad scope in the administration of local affairs, and in this respect the proposed regions stood for economic decentralization. On the other hand, as "Spectator" pointed out in *L'Est Européen*, the boundaries of the regions were to be drawn and their capitals located in a manner expressly designed to discourage the nationalistic aspirations of the various racial stocks in favor of the central government. The plan contemplated an interesting experiment in administration. We need but compare these economic regions with the geographical regions marked out by Tuckermann in the volumes referred to above, to see that the proposed organization represented a genuine attempt to adapt an important element of the administrative machinery of a great nation to permanent geographical facts.

Students of the history of political theory as well as of historical geography will find it profitable to compare the highly arbitrary and idealistic

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[5] For an historical account of the Moslem republics and provinces see Joseph Castagné: Les organisations soviétiques de la Russie musulmane, *Rev. du Monde Musulmane*, Vol. 51, 1922, pp. 1–254.

[6] Article cited in footnote 2, p. 270.

[7] See *L'Est Européen*, Vol. 3, 1922, pp. 277 ff.; *Riv. di Geogr. Didattica*, Vol. 6, 1922, pp. 135–141.

regional divisions of France adopted and suggested at the time of the French Revolution[8] with the more practical schemes based upon the ethnography, geography, and economic condition of the land adopted and suggested by the leaders of the Russian Revolution.

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[8] See the note "A Regional Division of France, 1790," *Geogr. Rev.*, Vol. 14, 1924, p. 144.

NOTES ON THE MAPPING OF AN AREA IN SOUTHERN HONDURAS

By Joseph H. Sinclair

The general geographical relations of the Republic of Honduras are fairly well known especially through the travels and writings of Squier, Wells, and Sapper.[1] It is a mountainous country with only a narrow border of coastal plain on the Atlantic and Pacific oceans and here and there river plains in the interior. The highest mountain summits attain an elevation of 10,000 feet above the sea in the Selague Mountains, Department of Gracias.

About three-fourths of the area of the country has a dry climate, the surface being occupied chiefly by savanas and a characteristic open forest of oak and pine: on the mountain slopes is a limited distribution of tropical and subtropical rain forest.[2] The remaining one-fourth, lying in the north and east, is humid and covered with tropical forests. Climatic conditions are healthful and in the main well suited to the white race over that portion having the semiarid climate. At Tegucigalpa, the capital, at an elevation of 3070 feet above the sea, two years' observations of temperature showed a maximum of 98° and a minimum of 46°; mean temperature of 66° in January and 76° in May, an average of 72° for the year.[3] A single year's observation of rainfall gives 1200 millimeters (47 inches).

Leggett[4] states that the temperature of San Juancito rarely rises higher than 85° F. At San Juancito rainfall measurements during 1920 and 1921[5] show a total rainfall for 1920 of 71.18 inches and for 1921 of 70.82 inches. The number of days on which rain fell in 1920 was 179, in 1921, 193. The greatest rainfall for each year occurred in the month of June, there being 16.19 inches in June, 1920, and 15.50 inches in June, 1921. The greatest single rainfall was 5.57 inches in 1920 and 4 inches in 1921. Mosquitoes are limited to the coastal plain areas, and hence malarial fevers are uncommon in the great interior highlands. In travels of more than two years the writer and his associates never slept under mosquito netting and did not meet with any one suffering from malaria.

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[1] E. G. Squier: Notes on Central America, Particularly the States of Honduras and San Salvador, New York, 1855.

William V. Wells: Explorations and Adventures in Honduras, New York, 1857.

Karl Sapper: Beiträge zur physischen Geographie von Honduras, *Zeitschr. der Gesell. für Erdkunde zu Berlin*, 1902, pp. 33–56, 143–164, and 231–241.

[2] See the vegetation map by Sapper, *op. cit.*, Pl. 3.

[3] Julius Hann: Handbuch der Klimatologie, Vol. 2, Stuttgart, 1910, p. 332.

[4] T. H. Leggett: Notes on the Rosario Mine at San Juancito, Honduras, C. A., *Trans. Amer. Inst. of Mining Engineers*, Vol. 17, 1888–1889, pp. 432–449.

[5] Private Report of A. R. Gordon, Vice President and General Manager of the New York and Honduras Rosario Mining Company, January 1, 1922.

General Character of the Area Mapped

It is the purpose of the present paper to give data on the elevations, geographic position, and topographic character of about 900 square miles situated in the southern part of Honduras between the village of San Lorenzo on the Gulf of Fonseca and a point a few miles north of Tegucigalpa.

FIG. 1—Reduction of the map of the San Juancito Mountains made by the author. The scale of the original is 1:12,000. The inset shows by diagonal ruling the area covered by triangulation (see Fig. 2): the black spot north of Tegucigalpa is the area of the contoured map.

In form this is a narrow rectangle about 80 miles long and 15 miles wide, the longer dimension having a north-south direction.

This region is situated in the semiarid portion of Honduras referred to above and ranges in elevation from sea level to 7500 feet above the sea in the San Juancito Mountains. The San Juancito Mountains, northeast of Tegucigalpa, are the chief mountain mass in the area. Not only is the mass important from its size and elevation, but it is famous for its mines of silver and gold which have been worked for centuries. The New York and Hon-

duras Rosario Mining Company[6] has now been mining here for over 40 years with a total bullion production (from 1882 to and including 1921) amounting to $30,354,754. There are several companies mining in this range, but none approach in importance that of the above-named company. The magnitude of the mining operations by this one company may be further realized from the fact that there are over 40 miles of tunnels on this property penetrating the San Juancito Mountains at levels of over 1600 feet vertical range. While in general the mountain summits of southern Honduras are treeless, the San Juancito Mountains form an exception. Their greater height exposes them to the trade winds and leads to greater precipitation, whence the upper portion of the range is clothed with forest. On the immediate summit, the highest elevation of which is 7500 feet, the forest consists of hardwoods. Here fog prevails; and the great trees, covered with an intense parasitical growth, constantly drip moisture. Before the exploration carried on by us the highest portion of this range had probably been rarely visited. At about 6000 feet the hardwoods give place to forests of pine; and at lower altitudes the forests before disappearing become completely open and parklike.

Next in importance to the San Juancito Mountains is the Sierra de Lepaterique, situated to the southwest of Tegucigalpa. We visited only the eastern portion of this mass, a summit called the Cerro de Hule, whose elevation we found to be 5637 feet above the sea. It is entirely bare of trees. The openness of the country is extraordinary. We often saw the volcanic peak of San Miguel in San Salvador, 90 miles distant, and from far in the interior the great peak of Conseguina in the Gulf of Fonseca.

The mountainous masses in the area described by us are of no regular form. They appear to be remnants of flows of lavas and ash deposits from fairly recent volcanic activity which doubtless formerly covered a much wider area. The Cerro de Hule of the Sierra de Lepaterique range is a broad, dome-shaped summit with smooth and gentle slopes; while on the other hand the San Juancito Mountains are a narrow, jagged ridge with sharp peaks and precipitous slopes which drop very abruptly from elevations of 7500 to 2500 feet above the sea. The great valleys carved back into this range offer scenic views of grandeur. They have cut through the andesites forming the summit and sides of the range and in places have exposed the underlying sedimentary rocks. In the contact zone occur the fissure veins whose mineral content has caused the extensive mining operations already referred to.

In 1909 the New York and Honduras Rosario Mining Company found itself in a position to enlarge the scope of its operations by the construction of new and larger mills for the treatment of the ore and by the construction of new hydro-electric plants and a new town for the accommodation of its

[6] W. A. Thatcher: Mining in Honduras, *Trans. Amer. Inst. of Mining Engineers*, Vol. 20, 1891, pp. 394–409. See also A. T. Haeberle: A Visit to the Department of Olancho, Honduras, *Bull. Pan. Amer. Union*, Vol. 34, 1912, pp. 588–606.

American and English employees. In connection with an intensive campaign for finding new ore deposits, it was decided to have the region accurately mapped topographically and geologically, and in the carrying out of the work the data published in this paper were secured. It is through the courtesy of the company that the results are now published.

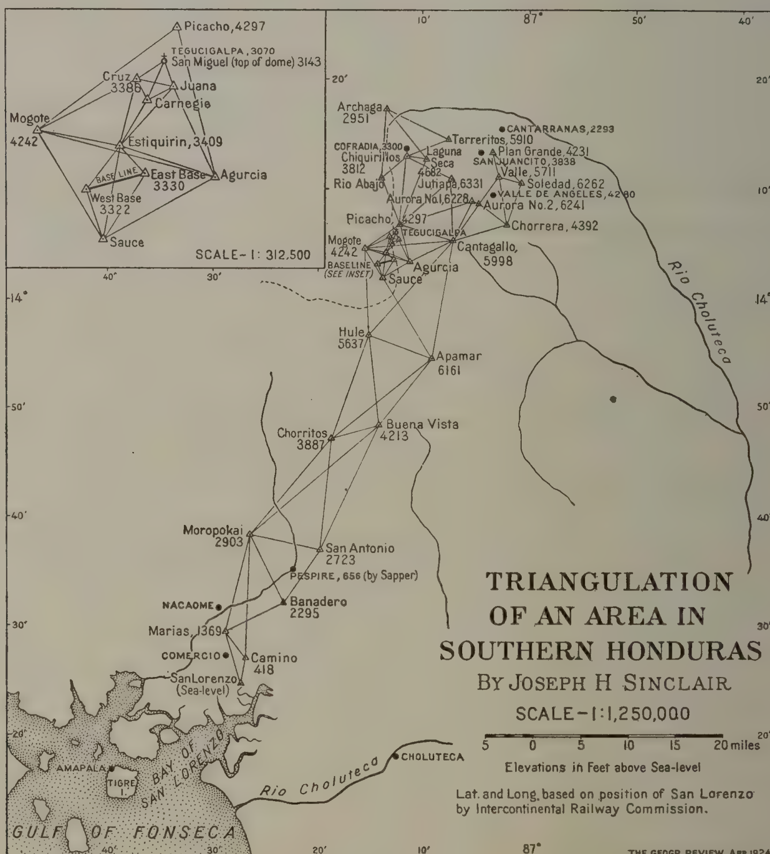

FIG. 2—Map showing the triangulation system carried out by the author in southern Honduras. The inset shows the area about Tegucigalpa on an enlarged scale.

Description of the Mapping

Survey operations began with the measurement of a base line on a plain called the "Llano de Potrero" situated about four miles south of Tegucigalpa. The length of this line was 1½ miles. From this a system of triangulation was extended over an area of about 900 square miles covering the San Juancito Mountains and extending south to the Pacific Ocean. Thirty-six stations were established, nearly all on prominent mountain peaks.

No observations for latitude and longitude were made by us because we were able to include as a station of our triangulation a point whose geo-

graphic co-ordinates had been determined with greater precision than was possible for us with the instruments and time at our disposal. This was the village of San Lorenzo on the Gulf of Fonseca, a station of the survey of Corps No. 1 of the Intercontinental Railway Commission[7] whose position we took from map XVI, sheet La Brea to Los Prados, as latitude 13° 24′ 36″ N. and longitude 87° 27′ 18″ west of Greenwich. Recalculating back from this point through the entire system of triangulation we have obtained the latitudes and longitudes of the entire region covered by it. Thus for the first time we know accurately the position of many towns—Tegucigalpa, San Juancito, Valle de Angeles, Cantarranas, Cofradia, and others.

The astronomic work carried on by us was limited to observations for azimuth on the star α Ursae Min. on July 31 and August 1, 1910. Later these observations were checked by incorporating an azimuth of the Carnegie Institution of Washington at Tegucigalpa[8] as a side of our triangulation, whereby an agreement within fourteen seconds was obtained.

The extension of the system of triangulation to the seacoast at San Lorenzo permitted us to carry elevations all over the triangulation by means of vertical angles between stations. Thus a large number of elevations has been secured of much greater accuracy than any hitherto obtained in Honduras. Fifty-one vertical angles were observed over the triangulation system, the average angle being 6° 02′ and the average length of sight 6.443 miles. A comparison of some of our elevations with several of those of Sapper[9] is as follows:

Place	Barometrical Elevation by Sapper in Feet	Vertical Angle Elevations by Sinclair in Feet
Tegucigalpa*	3214	3070†
Cofradia	3608	3300
Valle de Angeles	4493	4280
San Juancito*	4034	3838
Cantarranas	2394	2293

* Leggett, *op. cit.*, Tegucigalpa 2465 to 2500 feet elevation and San Juancito 3050 feet.

† This is on the assumption that the difference between the ground and the highest point of the rear dome of the cathedral of San Miguel at Tegucigalpa is 73 feet.

A contour map on a scale of 2000 feet to the inch, or 1:12,000, with a contour interval of 20 feet was made of 36 square miles of the higher portion of the San Juancito Mountains, and a copy of this is in the files of the American Geographical Society in New York. The data for this map were obtained by traverses with the plane-table and the stadia extending over a period of two years.

[7] Intercontinental Railway Commission: Reports of Surveys and Explorations, 7 vols., Washington, D. C., 1895–1898.

[8] L. A. Bauer: Land Magnetic Observations, 1905–1910 (Researches of the Department of Terrestrial Magnetism), *Carnegie Instn. Publ. No. 175*, Washington, D. C., 1912.

[9] Karl Sapper, *op. cit.*

In the following list of the elevations and geographic positions of 38 stations of the triangulation system, it should be noted that the names of these stations have been chosen by us arbitrarily. Some, perhaps most, of these stations can never be found accurately enough for extension of triangulation from them; but the elevations represent a permanent contribution to physiography, and where the stations occupy a sharp peak it is certain that such points could be used in extension of a secondary triangulation for mapping purposes.

Appendix

The following list of triangulation stations shows altitude, latitude, and longitude. A complete description is on file with the American Geographical Society.

Table I—Triangulation Stations in Honduras

Stations	Latitude	Longitude	Elevation (Feet)
Agurcia	14° 03′ 10.297″	87° 11′ 11.153″	——
Apamar	13° 54′ 08.834″	87° 09′ 21.601″	6161
Archaga	14° 17′ 19.892″	87° 13′ 30.515″	2951?
Aurora No. 1	14° 08′ 36.250″	87° 05′ 25.737″	6228
Aurora No. 2	14° 08′ 31.832″	87° 04′ 59.216″	6241
Bañadero	13° 31′ 45.469″	87° 23′ 29.804″	2295
Buenavista	13° 48′ 10.233″	87° 14′ 11.137″	4213
Camino	13° 26′ 47.389″	87° 26′ 57.878″	418
Cantagallo	14° 05′ 07.118″	87° 07′ 15.462″	5998
Carnegie	14° 05′ 06.760″	87° 12′ 57.188″	——
Cerro de Hule	13° 56′ 26.021″	87° 15′ 18.942″	5637
Chiquirillos	14° 12′ 37.917″	87° 11′ 32.177″	3812
Chorrera	14° 06′ 26.842″	87° 02′ 11.810″	4392 (top of flag)
Chorritos	13° 46′ 53.243″	87° 18′ 50.473″	3887
Cruz	14° 05′ 29.060″	87° 13′ 19.782″	3386
East Base	14° 03′ 12.977″	87° 13′ 07.009″	3330
Estiquirin	14° 03′ 59.604″	87° 13′ 35.606″	——
Juana	14° 05′ 16.139″	87° 12′ 34.841″	——
Jutiapa	14° 10′ 41.540″	87° 07′ 22.024″	6331
Laguna Seca	14° 12′ 31.835″	87° 09′ 34.112″	4682
Las Marias	13° 29′ 26.373″	87° 28′ 51.110″	1369
Mogote	14° 04′ 13.578″	87° 15′ 36.260″	4242
Montanita	14° 20′ 08.712″	87° 07′ 43.489″	——
Moropokai	13° 38′ 27.384″	87° 26′ 32.536″	2903
Picacho	14° 06′ 40.859″	87° 12′ 08.199″	4297
Plan Grande	14° 13′ 02.419″	87° 03′ 44.811″	4231
Rio Abajo	14° 10′ 45.749″	87° 13′ 55.783″	——
San Antonio	13° 36′ 58.033″	87° 20′ 02.905″	2723
San Lorenzo	13° 24′ 36.000″	87° 27′ 18.000″	15.6
San Miguel*	14° 05′ 57.383″	87° 12′ 43.929″	3143 (highest part of dome)

* Leggett, *op. cit.*, makes Tegucigalpa lat. 14° 15′ N., long. 87° 10′ W.

STATIONS	LATITUDE	LONGITUDE	ELEVATION (FEET)
Sauce	14° 01′ 36.438″	87° 13′ 58.723″	——
Soledad	14° 10′ 11.741″	87° 00′ 56.712″	6262
Station B	14° 12′ 56.304″	87° 05′ 33.079″	5725
Station E	14° 12′ 22.466″	87° 05′ 29.124″	5129
Station F	14° 12′ 20.770″	87° 05′ 14.921″	5080
Tegucigalpa See San Miguel			
Terreritos	14° 14′ 17.754″	87° 07′ 43.246″	5910
Valle	14° 10′ 49.564″	87° 03′ 01.637″	5711
West Base . . .	14° 02′ 54.768″	87° 14′ 23.875″	3322

TIDAL CURRENTS IN THE OPEN SEA: SUBSURFACE TIDAL CURRENTS AT NANTUCKET SHOALS LIGHT VESSEL

By Embert A. Le Lacheur
U. S. Coast and Geodetic Survey

The question is often asked, Is there a tide in the open sea? If there is such a phenomenon, is the current which accompanies it appreciably felt by the navigator? To answer these questions we must first know the difference between the terms "tide" and "tidal current."

The tide-producing forces of the sun and moon cause the water of the ocean to rise and fall vertically, resulting in the daily high and low tides with which we are familiar. Accompanying this vertical movement of the water a horizontal movement also takes place, resulting in the tidal current, commonly known as "flood" and "ebb."

Out in the open sea the vertical rise and fall of the water brought about by the tides is very slight and need not be taken into account by the mariner. The horizontal movement of the tidal current, however, is of considerable importance to the navigator when "on soundings." Offshore, away from the immediate influences of the coast, the tidal current is quite different from the current found in inland tidal waters. Instead of setting in one direction for a period of six hours and in the opposite direction during the following period of six hours, the tidal current offshore changes its direction continually, so that in a period of about twelve and a half hours it will have set in all directions of the compass. This type of current is called a rotary current in distinction from the reversing type of current found in inland tidal waters, such as the Delaware or Hudson Rivers.

Nantucket Shoals Light Vessel, in latitude 40° 37′ 02″ N. and longitude 69° 37′ 06″ W., is located farther offshore than any other light vessel on either the Atlantic or Pacific coasts of North America and is the first aid to navigation picked up by all ocean liners bound to New York from European ports. This station is approximately forty miles south by east from Nantucket Island, which is the nearest land, and fourteen miles southeast from Asia Rip, Phelps Bank, Nantucket Shoals. The light vessel is anchored in twenty-nine fathoms of water and is free to swing with current and wind to considerable anchor chain.

The Surface Current

The tidal current at Nantucket Shoals Light Vessel is of the rotary type, turning clockwise, as shown in Figure 1. In this diagram the times and velocities of the current have been referred to the times of the predicted tides

for Boston, Mass. The diurnal inequality in the tides is likewise reflected in the tidal current, as shown by the two ellipses in Figure 1. In the diagram, HH stands for higher high water, LL for lower low water, H for high water,

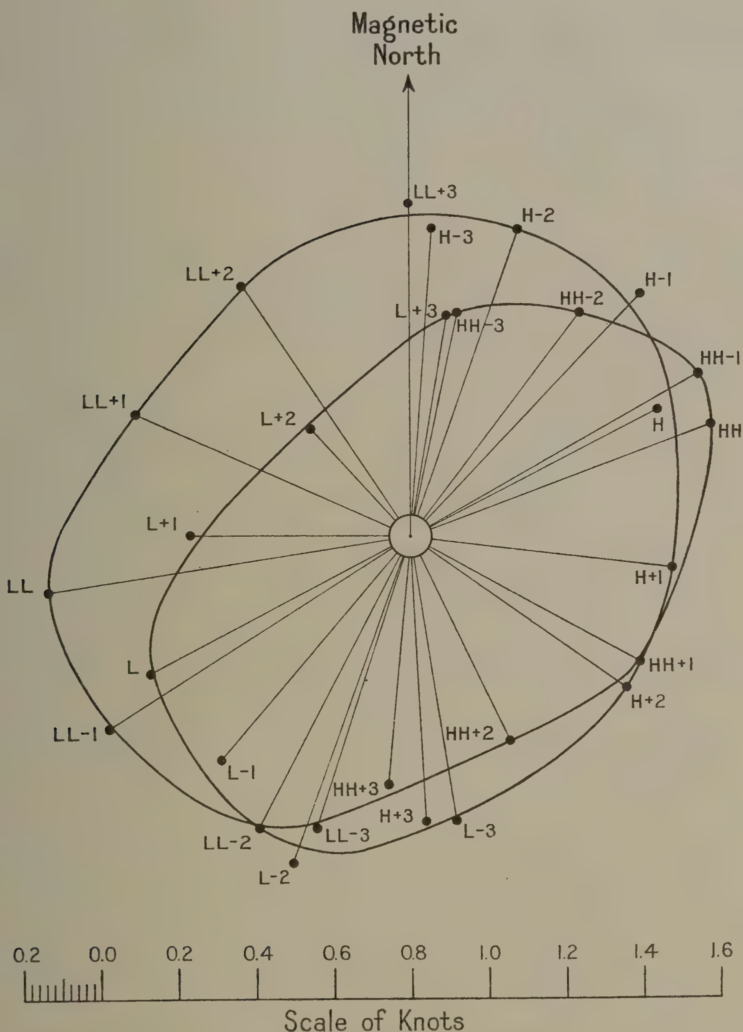

FIG. 1—Surface tidal current curve, Nantucket Shoals Light Vessel, September 1–29, 1919. Times and velocities are referred to predicted tides at Boston, Mass.

and L for low water. Twice in a lunar day of 24 hours and 50 minutes the tidal current swings around in a complete ellipse. Figure 1 shows the mean tidal current at Nantucket Shoals Light Vessel for the lunar month of Sept. 1–29, 1919. It will be noted that the major axes of the ellipses lie in a direction northeast-southwest.

The maximum flood surface current at the light vessel occurs about two hours before low water at Boston and sets S. 35° W. (true) with a velocity of 0.85 knot. The maximum ebb surface current occurs about two hours before high water at Boston and sets N. 35° E. (true) with a velocity of 0.85 knot. The minimum current before flood at the surface occurs about forty-five minutes after high water at Boston and sets southeasterly with a velocity of 0.65 knot, and the minimum current before ebb at the surface sets northwesterly with a velocity of 0.65 knot about fifty-five minutes after low water at Boston.

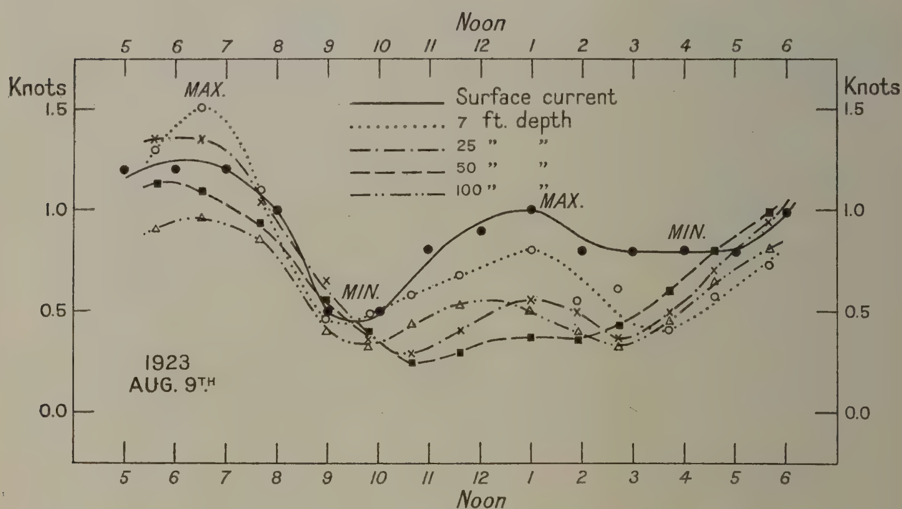

FIG. 2—Graph showing velocities of the current at the surface and at various depths at Nantucket Shoals Light Vessel, August 9, 1923.

A characteristic feature of the rotary current is the absence of slack water, such as occurs in a tidal river when a current which has been flowing ebb turns and flows in an opposite direction on the flood, and vice versa. Although the current generally varies from hour to hour, this variation from greatest current to least current and back again to greatest current does not give rise to a period of slack water. The minimum and maximum velocities of a rotary current are thus related to each other in the same way as slack and strength of current, a minimum velocity of the current following a maximum velocity by an interval of about three hours and being followed in turn by another maximum after a further interval of three hours.

For several years past, pole observations, which give the direction and velocity of the current at a mean depth of 7 feet, or, approximately, the surface current, have been made hourly at Nantucket Shoals Light Vessel. These have resulted in a very good determination of surface current conditions at this station. The directions and velocities of the maximum and

minimum tidal currents have been well determined. The observations indicate the existence of a non-tidal set, due primarily to winds, setting northwesterly with an average velocity of 0.17 knot from April to October and southeasterly with an average velocity of 0.13 knot from November to March.

From a long series of current pole observations—1911 to 1923 inclusive—it has been found that the velocity of the current due both to tide and

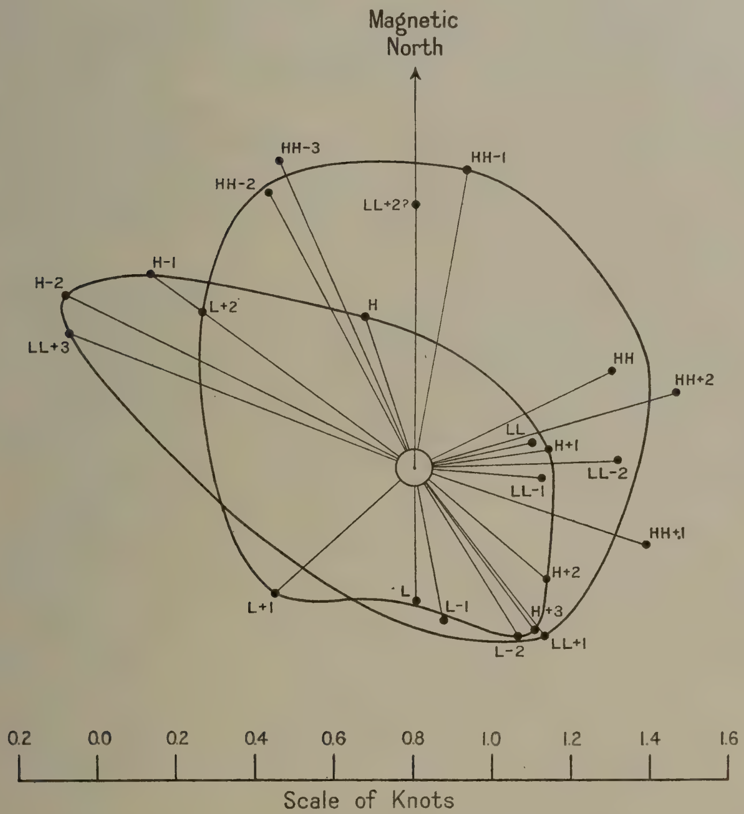

FIG. 3—Tidal current curve at a depth of 100 feet, Nantucket Shoals Light Vessel, August 8–10, 1923. Times and velocities are referred to predicted tides at Boston.

wind at Nantucket Shoals Light Vessel rarely exceeds two knots. The greatest observed velocity at this station occurred at 7 A. M., on December 8, 1913, when the current attained a strength of 2.5 knots an hour. A strong west-northwesterly gale with a velocity of 60 miles an hour obtained at this time.

SUBSURFACE CURRENTS

From August 8 to August 11, 1923, current observations at various subsurface depths, as well as those at the surface, were made at Nantucket

Shoals Light Vessel. The apparatus used consisted of a Price current meter and a bifilar suspension current direction indicator. The velocities and directions of the currents were observed at depths of 7, 25, 50, 100, and 150 feet, respectively.

The velocities of the currents observed on August 9, 1923, at the abovementioned depths, together with the surface current observations, have been plotted in Figure 2. The time interval from 5 A. M. to 5.30 P. M. represents half a lunar day. It will be noted that the velocities of the current at a given time generally decrease as the depth increases. The maximum and minimum velocities of the current at various depths are indicated by the plottings. The symbol Max. refers to the maximum current, and the symbol Min. to the minimum current. It will be noted that two maximum and two minimum velocities occur at each depth during a twelve-and-a-half-hour period. This would correspond to strength of flood, slack before ebb, strength of ebb, and slack before flood in the case of a reversing tidal current such as obtains in a tidal river like the Delaware or a tidal bay like the Chesapeake.

While this current series (Aug. 8–11, 1923) is rather short in extent, the results obtained indicate clearly that the subsurface tidal currents at this offshore station act quite differently from those at the surface. This is true in direction as well as velocity of the current at a given time. Figure 3 shows a plotting of the current observations at a depth of 100 feet, or, roughly, two-thirds of the distance from the surface to the bottom. These observations have been referred to the times of the predicted high and low waters for Boston, Mass., similarly to those shown in Figure 1. The minus sign means "earlier than," and the plus sign "later than" the tides at Boston. For instance, in Figure 3 the direction of the current at a depth of 100 feet at Nantucket Shoals Light Vessel was N. 82° E. (magnetic) one hour after the time of high water at Boston, shown on the diagram by "H+1". It will be noted that the current is rotary, swinging around in a clockwise direction. However, the major axes of the two ellipses lie northwesterly-southeasterly, or 90 degrees in a counterclockwise direction from those representing the surface current. For depths from the surface to 100 feet, the axes of the ellipses gradually swing around in a counterclockwise direction. This shows, therefore, that the maximum current occurs much later at subsurface depths than it does at the surface.

The results of these offshore observations bring to light probably for the first time the facts that, although the subsurface currents are rotary in type, they lag behind the surface current in direction and have a velocity considerably less than the surface current. In this short series of observations this lag is very noticeable at depths of 25 feet, 50 feet, and 100 feet.

NOTES ON THE MAPPING PROGRAM OF THE THIRD ASIATIC EXPEDITION IN MONGOLIA

By Frederick K. Morris

An account of the work of the Third Asiatic Expedition was given by the leader, Roy Chapman Andrews, at the December Meeting of the American Geographical Society. The following brief notes regarding the survey work in a vast unknown terrain are supplied by Professor Morris, geologist and topographer to the Expedition.

The Gobi is a vast inland basin, made by a warping or bending of the earth's crust, so that a cradle-like depression lies between the two upraised edges that border Mongolia on the north and south. From the northern

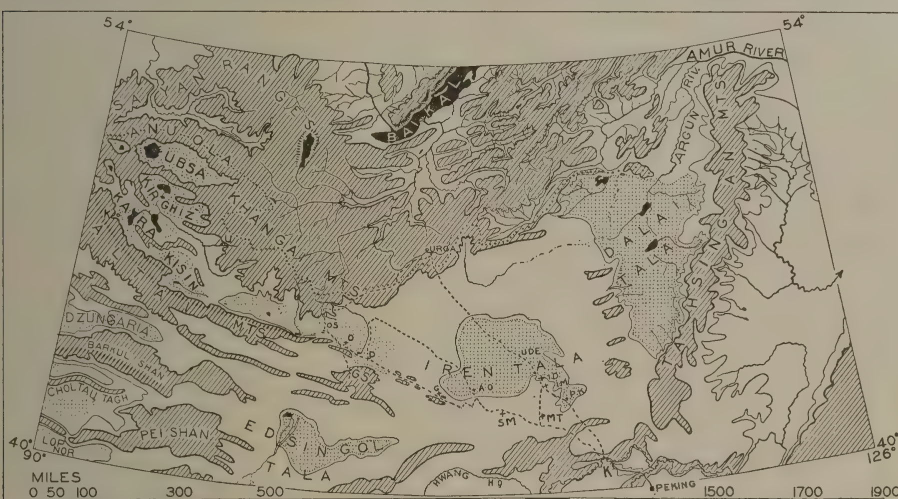

Fig. 1—Physical geography of Mongolia. The mountain areas are shaded with slanting lines. Three kinds of mountain uplift may be distinguished—the short fault blocks east of Lake Baikal; the broad gentle upwarp of the Khangai Mountains; and the long narrow fault blocks of the Altai and the ranges to the southward. The great warped basins are white, but the deeper depressions, *talas*, of these basins are shaded with dots. Most of the sediments bearing remains of extinct vertebrates are found in the talas. The route of the Expedition is shown in broken lines, the major hydrographic divide in heavy round dots.

Index letters are given in succession from Peking north and west: K, Kalgan; PK, Pang Kiang; IM, Irdin Manha, where titanotheres were found; ID, Iren Dabasu, a dinosaur locality; MT, Murukh Tchu; SM, Shara Murun, a titanotheres station; AO, Ardyn Obo, Cadurcotherium beds; G, Golobai-in-Ola; D, Djadochta, dinosaurs and their eggs; O, Oshih or Ashile, dinosaur locality; OS, Ondai Sair, a dinosaur locality, just south of which lie the Baluchitherium beds and the Miocene and Pliocene formations.

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edge we pass through a wide belt of mountain country to the great lowland of Siberia; from the southern, the land surface drops abruptly into China. A great chain of such uplifted basins lies across the continent of Asia, including the Gobi, Dzungaria, the Lop or Tarim, the Tsaidam and Tibet, the Iran and Sistan, the Balkhash, Aral and Caspian basins.

FIG. 2—Sketch showing the edge of a great hollow or lowland eroded in the horizontal sediments of the Gobi. The sketch also shows an *obo*, or devotional stone pile. This one is called Ardyn Obo (see Fig. 1), which freely translated means "Prayer Pile of Jewels," an allusion to the brilliantly polished pebbles here found in the upper conglomerates. This obo can be seen for twenty miles.

Aspects of the Country

The rock surface of the Gobi is interrupted by broad shallow depressions in which are found deposits of gravel, sand, and clay that here and there carry the bones of extinct animals. Breaking the level surface of these sediments are smaller depressions or hollows, where the sand and clay have been eroded away and the cut edges of the sediments are exposed. Rising above the level surface of the sediments are knobs of the hard rock floor, some of them small, others large enough to form considerable areas of mountain country.

In the easterly section between Kalgan and Urga there is a seemingly endless succession of these sedimentary basins, parted by low broad mountain masses. In the west, the Altai ranges rise as a long chain of fault blocks with their steep front on the north. In this western region, too, we find sediment basins both north and south of the Altai. To the south, where the two geologists of the Expedition made a brief reconnaissance in 1922, there seem to be vast areas of monotonous basin land. On the north the sediment basins are more rugged, more deeply dissected, and interrupted at many places by low ranges of ancient rocks that stand above the broad level lowlands of sediment like islands in a sea.

The broad extent of the Khangai Mountains, to the north and northeast of the Altai, is maturely dissected and gently sloping, rising gradually to about 10,000 feet at the Arctic divide and then descending along a still gentler slope northward into the lowlands of Siberia. The only traces of glaciation seen by members of the Expedition were the young cirques of the Khangai.

The western limits of the Gobi are in the mountains that group between the Altai and Sayan systems; while to the southwest are gaps or gateways opening into the lowlands of Dzungaria and the Tarim basins.

The area of Mongolia is given according to recent estimates as about one and a third million square miles, or nearly half the area of the United States. The Expedition could cover only a small fraction of this vast territory in the reconnaissance journey of 1922; and in 1923 the regions that had proved to contain vertebrate fossils were studied intensively, so

Fig. 3—Sketch of the major divide in the Khangai Mountains, looking northwest. All rivers seen in the sketch flow southward into the Gobi. The rivers north of the divide flow through Siberia to the Arctic Ocean. Alpine glaciers have carved cirques in the broad rounded surface of these very mature mountains.

that not much new territory could be added to the survey. The route of the Expedition, shown on the map, is in the aggregate about 3600 miles long. So large a course would have been impossible for an expedition lacking motor transport, because the season in which scientific work can be done is only five months long. We go out in the early spring, taking advantage of a short period of warmth that lasts a week or two. Then the cold strikes us sweeping down from the northwest, and in an hour the season has changed from spring back again to winter until June comes round again. Summer is clear and hot but brief. A cool sharp freshness, like the feel of wind-blown ocean spray, comes in the early mornings about mid-August and warns us that our working season is nearly done. We do not start back until September; but we are very likely to run through blizzards before we drop down from the great pass above Kalgan.

To explore such a country with camels at twenty miles a day would be almost impossible; the paucity of scientific results of many previous expeditions that have traversed Mongolia is surely due in part to their lack of adequate transport. So the Third Asiatic Expedition traveled in motor cars—four light trucks and one touring car—supported by a caravan of camels. The mode of travel has been fully described by Mr. Andrews in the serial narrative published in *Asia*.

The Topographical Record

The recording of topographical notes in such a country presented rather peculiar problems. Depending chiefly upon the time available, some four types of record were devised, which are stated in ascending order from the least to the most detailed.

When the Expedition was moving at great speed from one base to another, rapid freehand sketches were made of the passing hills. These for the most part were sketched without stopping the car. They make no pretense to quantitative value, but they give the quality of the country. An effort was made to record in this way every notable change in the kind of topography through which the Expedition passed.

When the two geologists were working together, one of them sketched a route map while moving from place to place, as a better record than the

pictorial sketches. Distances were read in miles from the speedometer; aneroid readings gave elevations along the road; and other elevations were judged by eye. Lateral distances were estimated or were somewhat controlled by a crude triangulation. When bearings were to be taken, the car was stopped and the directions were read by stepping away from the car and sighting with a Brunton compass. About 1500 miles of such route map have been made. With all its imperfections, it still remains a more definite record than has yet been made in these regions.

When the Expedition camped for a while, a more regular type of map

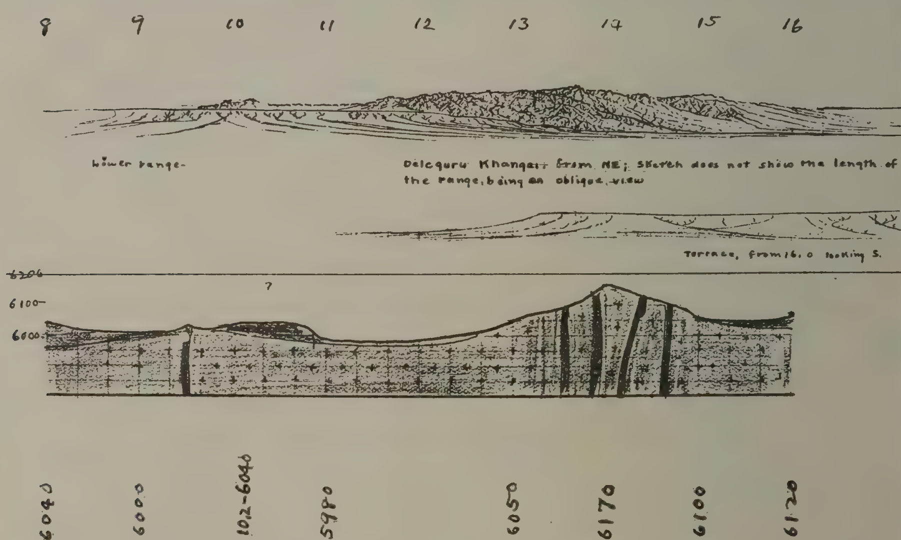

FIG. 4—Page of geologist's notebook (reduced scale), showing a sketch rapidly made from the moving car. The mountain block here represented is called Deleguru Khangai and is entirely unknown to the outside world. It is not to be confused with the Khangai Mountains, which lie more than 100 miles northwest of Deleguru. The figures along the top of the page are miles; those along the base are altitudes in feet, read from an aneroid barometer. A geological cross section is constructed for the entire route.

was made. Rapid compass surveys, controlled by pacing and triangulation, were entered directly in the geologists' notebooks. From time to time these were compiled upon a summary map, so as to cover a larger region. The scale was ¼ inch to the mile, and the contour intervals generally employed were twenty or forty feet.

At all important camps observations were made for latitude and longitude. Latitude was determined by observing the polestar. A single observation is sufficient if one applies the necessary corrections; but to insure accuracy the geologist took a series of readings at intervals of half an hour. Plotted on co-ordinate paper these points were tested by passing a circle through them, which would have revealed any errors. Longitude was determined by the sun; and here also, to guard against errors, a long series of readings was taken and carefully plotted. We shall carry wireless apparatus for the next field season; but we relied upon chronometer watches

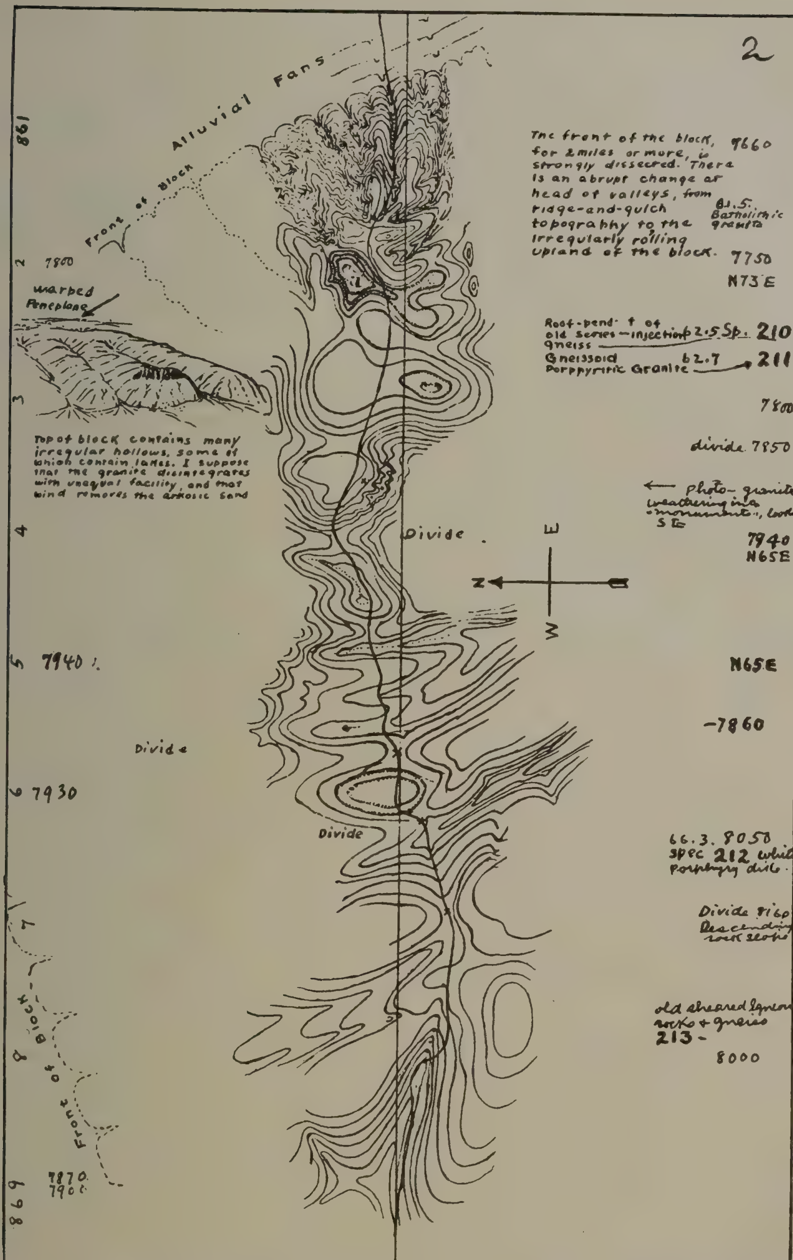

FIG. 5—A page of the geologist's field notebook, showing a section of the route map, sketched in the motor car and drafted in camp at night. This map shows the end of a broad low fault block, in whose peneplaned upland surface are a number of undrained hollows holding small lakes. These hollows are the result of atmospheric weathering and removal of the products of weathering by wind. The rock is granite.

in 1922 and 1923. One of the watches was loaned to the Expedition by the Geological Survey of China, and the Expedition is indebted to the Survey also for the loan of a light mountain theodolite in 1922. In the second season a large transit was used, and the heavier instrument is most heartily recommended. The Expedition has acquired a large Gurley transit, with straight leg tripod, for 1925.

When especially interesting regions were studied, maps were surveyed with a Gurley explorer's alidade and a light plane-table, which carried a sheet 18 by 24 inches. The stadia rods were designed by the geologists upon strips of heavy cloth-backed paper that could be rolled up when not in use. The reading face of the rod is four inches broad, providing excellent visibility. An interesting aid to the survey was found in the stone monuments called *obos*, which the Mongols have built. Each stone is said to represent a prayer to Buddha, and surely each monument evoked a blessing from the topographer. Almost every hill is crowned with an obo, so that in triangulating the map-maker may sight upon the very same spot every time he uses that hill in intersection or resection, or for a set-up.

Maps were drawn to the scales of an inch to the mile or two inches to the mile. Contour intervals varied with the quality of the ground—10 feet, 20 feet, and 100 feet. The largest area was covered in the Altai region, where some especially interesting problems present themselves. It is a region in which since the close of Jurassic time certain earth movements have been in progress, warping the earth's crust so as to form alternate basins and domes or swells. From the higher ground sediment has washed down into the lower, and in these gravels, sands, and clays we occasionally find bones of extinct animals. The warping movements were renewed from time to time, and the most severe movements fractured the earth's crust along fault lines. On the uplifted side of the faults the rocks rose gradually by small, rudely rhythmic increments of movement until mountains—the Altai ranges—were made. On the downthrown side sediments continued to gather in increasing thickness, sheet upon sheet of sand, clay, and rock fragments washed down from the growing mountain. Volcanic outbursts along or near the fault fissures added floods of lava to the deposits in the basins. The map which covers this region includes bad lands, a study of desert drainage, salt lakes, lava flows, some lying horizontal and others upturned, two fault-block mountain masses, and two warped peneplanes. The scale is one inch to the mile, with 20-foot contours for the basins and 100-foot contours for the mountain blocks. The map covers about 700 square miles.

These are the four types of topographical record attempted in the field—the freehand sketch, the sketched route map, the compass survey, and the plane-table survey with telescopic alidade.

Lastly, the geologists are preparing summary maps of Mongolia as a whole on a small scale, recording in generalized form all the changes or corrections they feel justified in making in existing maps, as well as a summary of the known geology.

THE TWENTIETH ANNUAL MEETING OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS

The Association of American Geographers met in Cincinnati on December 27–29, 1923, for the twentieth annual meeting. A joint meeting with Section E (Geology and Geography) of the American Association for the Advancement of Science brought together the adherents of both sciences. The meeting was held in the Old Technology Building of the University of Cincinnati, in the rooms of the Department of Geology. Of the thirty-one papers announced, twenty-three were presented and four were read by title.

In the field of cartography Professor J. Paul Goode of the University of Chicago presented his new world-projection in its final form. This consists of a welding together at 40° N. and 40° S. of Sanson's and Mollweide's projections, the former being used in the middle zone and the latter in the two poleward caps limited by those parallels. In addition, the net is interrupted along certain meridians north and south of the equator (40° W. north and 100° W., 20° W., and 80° E. south) to "ease" the cramped representation at the poles which characterizes Mollweide's projection in its usual form of a continuous, ellipse-bounded net for the whole world. There results a representation in which each continent is more or less balanced on its own central meridian. The same projection lends itself to a continuous representation of the oceans if the interrupting meridians be placed at 100° W. and 110° E. in the northern, and 70° W. and 140° E. in the southern hemisphere. This form of the projection was also presented.

Three papers dealt with meteorology and climatology. Professor R. DeC. Ward of Harvard University described the activities of the International Ice Patrol (see *Geogr. Rev.*, Vol. 14, 1924, pp. 50–61). The two other papers were an outgrowth of work done under Dr. C. F. Brooks of Clark University. Mr. George F. Howe (introduced) dealt with the summer and winter weather of selected cities of North America. Thirteen types of weather, derived from the combination of four classes of temperature, two of precipitation, and two of wind, were recognized. His maps showed the number of days for each city during which one of the established weather types prevailed. Mr. J. E. Switzer (introduced) spoke on "Weather Types in the Climate of Mexico." The steady warmth of the tropics (compare Professor Jefferson in *Geogr. Rev.*, Vol. 6, 1918, pp. 240–267) was brought out in a series of graphs of the daily temperatures of selected cities in Mexico.

Professor E. N. Transeau of Ohio State University discussed the plant geography of Ohio and illustrated the distribution of critical plants. Professor A. E. Waller of the same institution spoke on "Light as a Factor in the Distribution of Flax." Reporting that the answer was now available to the question he had raised at the fourth joint meeting of the American Geographical Society and the Association of American Geographers in April, 1920, as to the cause of the existence of a relict flora in Gaspé Peninsula, Quebec, Professor M. L. Fernald of Harvard University, in a paper entitled "The Flora of the Unglaciated Regions of Northwestern North America," stated the cause to be that that region had not been glaciated during the Ice Age. The botanical evidence was confirmed by the geological field work of Professor A. P. Coleman of the University of Toronto (compare F. J. Alcock's paper "Across Gaspé" in this number of the *Review*). Similar joint botanical and geological field work seems to indicate that the Long Range peninsula of Newfoundland likewise was not glaciated.

Nine papers were devoted to economic geography. Professor R. H. Whitbeck dealt with "The Ohio River as a Waterway." Mr. E. C. Case (introduced) of the Depart-

ment of Geology of the University of Cincinnati read a paper on "The Relation of Manufacturing to Natural Environment in the Valley of East Tennessee." Professor A. E. Parkins of the George Peabody College of Nashville described the recent growth in Southern cotton manufacture in a paper of that title and outlined the general conditions which favored the movement of cotton mills from New England to the South. Dr. Helen M. Strong of the University of Missouri read a paper, illustrated by graphs for the post-war period, on "The Geography of Our European Export Trade in Agricultural Products."

Two papers related to Canada. As a result of a field trip Professor C. C. Colby of the University of Chicago presented an excellent "Geographical Analysis of the Apple Industry in the Annapolis Valley, Nova Scotia," in which he discussed the climatic and locational advantages which have made this region the chief source of supply for Great Britain. Mr. Clarence F. Jones (introduced) of Clark University read a paper entitled "Railway Entrances and Terminal Facilities at Montreal" in which one of the routes of access he described dealt with the Canadian Northern Railway and the manner in which it overcame the topographic conditions in reaching the heart of the city.

Three papers dealt with Latin American topics. Mr. P. E. James (introduced) of the University of Michigan discussed the development of transportation in South America and illustrated his paper by maps of the continent showing the lines and means of communication at certain critical dates. Miss Alice Foster (introduced) of Mount Holyoke College gave a geographical interpretation of the cotton manufacturing industry in Orizaba, Mexico, based on a long sojourn in that country. Mr. F. A. Carlson (introduced) of the University of Ohio, Athens, Ohio, read a paper entitled "A Survey of Brazilian Agriculture." The paper was a result of work done in connection with an atlas of the agricultural geography of Brazil under preparation by the Brazilian Government.

Professor N. A. Bengtson of the University of Nebraska gave a sketch of the regional geography of the Santa Elena Peninsula, Ecuador, at the northern entrance to the Gulf of Guayaquil. The paper was illustrated by a large-scale physical map of the region, with altitude tints, based on original surveys. Professor W. M. Davis reported the results of his recent investigation of the Lesser Antilles, as a consequence of which he developed the concept and suggested the term of "marginal belt" for the poleward margins of the coral belt, in which, owing to the increasingly unfavorable conditions for coral growth, the coral islands have not always had the protection of an encircling reef. Dr. G. R. Mansfield of the U. S. Geological Survey gave a description of the various elements of the geography of southeastern Idaho. Professor Wellington D. Jones of the University of Chicago exhibited a map of a portion of Chicago classified into various types of districts as an illustration of the topic of his paper, "Field Mapping of Geographic Data." Professor S. S. Visher of the University of Indiana spoke on "Estimating the Comparative Richness of a State" and discussed the criteria that come into consideration. Professor N. M. Fenneman of the University of Cincinnati was unable to present his paper on "Some Geographic Problems in Australia" owing to the absorption of his time as a member of the local committee. To Professor Fenneman the Association and Section E are indebted for the excellent arrangements which characterized the sessions held in the congenial atmosphere of his department.

The whole of Friday, December 28, was devoted to joint sessions with Section E of the American Association for the Advancement of Science. In an address entitled "Seventy-Five Years of American Geology" the venerable dean of American geologists, Professor T. C. Chamberlin of the University of Chicago, gave a masterly review of the development of the science in this country during the lifetime of the Association. Professor Chamberlin's address dealt with the growth of our knowledge in that period as to the areal geology of the United States, the range of the geological column, the constitution of matter, the origin and composition of the earth. Professor W. M.

Davis gave a similar review, under the title of "The Development of Geography in the United States," of the growth of American geography since the colonial period. These two papers and the addresses of Professors Huntington and Shimer, mentioned below, will be published in *Science.*

After these two historical reviews Colonel C. H. Birdseye of the U. S. Geological Survey gave an account, illustrated by lantern slides, of his and his Survey party's recent boat trip down the Colorado River through the Grand Canyon (see this number of the *Review*, pp. 177-196).

Basing his remarks on his recent trip to the western Pacific Dr. Ellsworth Huntington in his presidential address, entitled "Geography and Natural Selection," cited mainly the cases of Australia and China to illustrate his theme.

The address of Professor H. W. Shimer, retiring president of Section E, on "Some Forces in Man's Social Evolution" was a lucid and masterful account of the social evolution of man as revealed by the development of our knowledge of biology, anthropology, and psychology.

A symposium held by the Ecological Society of America on the relation of general ecology to human ecology was of especial interest to geographers. The subjects dealt with were as follows: the relation of land and sea to organisms and to man; the relation of the atmosphere to plants, to animals, and to man; the relation of plant ecology through agriculture and horticulture to man; the relation of plant ecology through forestry to man; the relation of ecology to society and human behavior; the relation of nature to man as illustrated by the North American Indian.

During the last session of the Association of American Geographers Professor C. R. Dryer made some remarks on a review he is preparing of geographic education in the United States during the last hundred years. This is to appear in the *Annals* of the Association, together with a history of the Association during the twenty years of its existence, which has been prepared by Professor A. P. Brigham. At this meeting the Association was regretfully forced to cede to the desire of Professor Richard E. Dodge to withdraw from the office of secretary and editor to which he had been successively reëlected for many years. At the close of the session President Huntington voiced the universal sentiment of the members in expressing to Professor Dodge the Association's deep appreciation of all that he had done in promoting its welfare. To Professor Davis, its founder, and to Professor Dodge, its long-time secretary, the growth and development of the Association in the twenty years of its existence are in large measure due.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of January and February. The annual meeting of the American Geographical Society was held on January 22, at the Engineering Societies' Building, 29 West Thirty-ninth Street. After the reading of the annual reports and the election of officers for 1924 the Society was addressed by Sir Percy Sykes on "The Heart of Asia and the Roof of the World." Sir Percy has spent more than thirty years in Persia and Central Asia in various military and civil capacities. During this time he traveled extensively on the frontiers of India, Tibet, and Chinese Turkestan; he was the first European to cross the great Persian deserts in the footsteps of Marco Polo. At the regular monthly meeting held on February 26 a lecture illustrated by moving pictures was given by Mr. Horace D. Ashton on "A Caravan Journey into the Northern Sahara."

Elections to Fellowship. At the January meeting of the Society, President Greenough presiding, and the February meeting, Vice-President Henry presiding, there were presented with the approval of the Council the names of 121 candidates who were duly elected as Fellows.

Annual Reports of the Society. At the annual meeting of the American Geographical Society, held on January 22 at the Engineering Societies' Building, 29 West Thirty-ninth Street, the annual reports of the Council, of the Treasurer, and of the Special Committee were read as follows:

Report of the Council

New York, January 17, 1924

To the Fellows of the Society:

The year has been marked by substantial and gratifying advances in the Society's program of research and in the value of its publications, as well as their appreciation among scholars. First of all, mention should be made of the *Geographical Review*, the quarterly magazine of the Society, which forms the principal point of contact with the Fellows and with the scientific public. A large number of correspondents both at home and abroad testify to the high reputation and standing of the *Review*, and it is the purpose of the Society to maintain and extend its present distinction. The articles published in the four numbers of 1923 relate to almost every important division of the subject of geography, dealing with scenic features of outstanding interest, with recent discoveries and explorations by leaders in the field, with the economic geography of commercial frontiers, with the geography of densely populated districts and cities, such as Stockholm, Paris, Strasbourg, and the like, and with the geographical conditions that surround pioneer life in the thinly populated districts of the world. In the field of political geography there have been papers on boundary disputes and the history of boundary changes. Historical geography has had a part in our program, and physiography, oceanography, and climatology likewise. The demand for reprints of the leading articles and for copies of separate colored maps has been greater than ever, and we are convinced that the nature of the demand is such that our published material is a contribution toward the solution of many problems of outstanding interest today. While our aim is to publish a magazine of interest to a wide circle of lay readers as well as the scientific public, it is in no sense devoted to purely popular objects. It aims rather to make substantial contributions to knowledge and to publish these in a manner as attractive as the subject permits.

The monographs, special publications, and maps of the Society form a group of contributions both substantial and distinctive in character. During the year there have been published books and maps as follows:

Books

1. New York Walk Book. By Messrs. Torrey, Place, and Dickinson.

(A description of the scenery about New York and the roads and trails that provide access to open places. The book is in the general style of Dr. Dickinson's booklet on Palisades Interstate Park.)

2. The Land Systems of Mexico. By George McC. McBride.

(An intensive study of the use of the land and its geographical relations. It is now being translated into Spanish for wide distribution in Mexico under the auspices and by direction of the Government.)

3. The Vegetation and Soils of Africa. By H. L. Shantz and C. F. Marbut.

(Illustrated by maps of the soils, vegetation, land classification, and rainfall of Africa, and published jointly with the National Research Council.)

4. Aids to Geographical Research: Bibliographies and Periodicals. By John Kirtland Wright.

(Designed as an aid to research and locating published materials on a given subject.)

Maps

1. New York Walk Book Maps.

(Eight maps in color on the scale of 1 inch to 2 miles reduced from the sheets of the United States Geological Survey with many corrections and additions. They cover the area dealt with in the text of the New York Walk Book.)

2. Vegetation Map of Africa, 1:10,000,000 (about 32 miles to 1 inch). By H. L. Shantz.

(Accompanies "Vegetation and Soils of Africa." It shows vegetation, in color, and contains an inset on the scale of 1:25,000,000 by C. F. Marbut showing kinds of soil.)

3. Land Classification of Africa, 1:10,000,000 (about 32 miles to 1 inch). By H. L. Shantz and C. F. Marbut.

(Also accompanies "Vegetation and Soils of Africa." It shows agricultural potentiality and for what types of utilization each area is suited and the degree of potential productivity within each type. It contains an inset on the scale of 1:25,000,000 by J. B. Kincer of the U. S. Weather Bureau showing rainfall.)

4. Base Map of Hispanic America, 1:6,000,000 (about 70 miles to 1 inch).

(A black and white base map in three sheets compiled from over 200 sources.)

During 1923 one gold medal was awarded, the David Livingstone Centenary Medal to Professor Griffith Taylor of the University of Sydney, Australia. The distinguished work of Professor Griffith Taylor, of which this medal is a form of recognition, was described in the July number of the *Geographical Review.* It includes field work and monographs on the geography of Australia with particular reference to problems of rainfall and settlement and the economic geography of the unpopulated or thinly populated frontier regions of that continent.

The Society has made good progress upon its major plan of research in the field of Hispanic America. It has advanced the compilation of thirty-three sheets in a satisfactory manner and during the coming year will produce nearly a dozen sheets in

standard form, besides carrying well toward completion an equal number of other sheets in hand. Its aim has been to extend its operations on a broad front rather than to produce finished sheets to a maximum number. In this manner it avoids duplication in the arduous work of reference and compilation upon which the value of its map program so largely depends. It also enables the Society to secure an increasingly large number of original surveys from the files of commercial companies, exploring parties, and other private and hitherto unpublished sources. Associated with its map program is the compilation of a great index of maps of Hispanic America in which wide interest has been shown by research institutions, university departments of geography, and kindred societies in all parts of the world. It is with deep satisfaction that the Society records the approval of the National Research Council in this work of scholarship. At its annual meeting on April 18, 1923, the Division of Geology and Geography of the National Research Council, after expressing its interest in the furtherance of this work, adopted the following resolution:

"RESOLVED that the National Research Council regards the catalogue of Hispanic-American maps now in preparation by the American Geographical Society as a work of fundamental importance in relation to scientific research and urges its early completion and publication."

In addition it voted the sum of $600 as a contribution toward the expense of completing the catalogue, provided additional funds were secured; and this the Society has succeeded in doing. It is proposed to complete the catalogue in the course of the next few years and either to typewrite it in duplicate copies or photostat it, binding the results in seven or eight volumes, in a limited edition, to be sold at cost. It will contain references to all the maps, probably not less than 15,000 in number, which can be found by the committee of scholars in charge and will, we hope, form a standard work of reference for many years to come.

The Society has continued its cordial relations with the Association of American Geographers and maintains the policy, begun years ago, of sending the *Geographical Review*, free of charge, to members of the Association, thereby placing within reach of every member of the Association the latest and most authoritative comment upon the progress of geographical knowledge throughout the world.

The Society has followed its former custom of sending representatives to important scientific gatherings and occasions of special geographical interest. On November 19, 1923, on the invitation of the Academic Council of the University of La Plata, Mr. Willing Spencer, Counselor of the American Embassy at Buenos Aires, represented the Society at the unveiling of a memorial to Dr. Francisco P. Moreno. Dr. Moreno was awarded the Cullum Geographical Medal of the American Geographical Society in 1909 in recognition of his distinguished work in surveying the lake region of Patagonia and of his cartographic researches and field work in the plateau country of the Puna de Atacama in northwestern Argentina.

On the invitation of the officers of the Australian National Research Council the Society appointed two representatives, Mr. A. H. Brooks, of the U. S. Geological Survey, and Professor N. M. Fenneman, of the University of Cincinnati, to represent it at the sessions of the Pan-Pacific Science Congress held in August and September, 1923, at Melbourne and Sydney. It was during one of the general sessions of the Congress held at Sydney that Professor Griffith Taylor was presented with the David Livingstone Centenary Medal of the Society by one of our representatives. The Congress was well attended by American geographers and marked an important step in the organization of geographical knowledge and field work in the Pacific realm.

In addition, President Greenough represented the Society on the occasion of the inauguration ceremonies of Samuel Wesley Stratton as the President of the Massachusetts Institute of Technology on June 11, 1923; and the Director of the Society represented it on February 3, 1923, at a meeting at the United States National Mu-

seum in commemoration of the one hundredth anniversary of the birth of Spencer Fullerton Baird, former Secretary of the Smithsonian Institution.

Additions to the library during the year comprise 1267 books, 474 pamphlets, 6375 periodicals, 4185 maps, 117 atlases. The collection now numbers 63,945 volumes of books and pamphlets and 61,530 atlases and maps. Mr. Francis Burton Harrison, former Governor-General of the Philippines, has presented to the Society 513 books and periodicals, 551 maps, and 18 atlases dealing primarily with military events in Europe in the eighteenth and early nineteenth centuries. These form a valuable collection of source materials not only for the history of the campaigns of the Seven Years' War and the Wars of the French Revolution and of Napoleon but also for the history of cartography. To supplement the dictionary catalogue of the Society's library a new catalogue was begun in February, 1923. This is a class catalogue, designed especially as an aid to the research worker. In it are filed cards referring to all books and to all important geographical articles in serials received. The cards are arranged by topics and by regions with a view toward enabling the consultant to find grouped together in one place references to all important publications dealing with the particular subject of his investigations. An important feature is a series of maps which serves as a key to the regional arrangement of the cards.

The lectures of the Society have been well attended and appreciated. The speakers have been as follows:

The Reverend Hugh Birckhead, "Palestine, the Shrine of Three Great World Religions;" Captain Kilroy Harris, "Through Unknown Australia;" T. Alexander Barns, "The Eastern Congo and the Land of the Giant Craters;" Carveth Wells, "My Six Years in the Jungle of Malay;" Lieut.-Col. William Warfield, "An Intimate View of the Balkans;" Major E. Alexander Powell, "By Camel and Car to the Peacock Throne;" Roy Chapman Andrews, "The Third Asiatic Expedition."

The preparation for the active prosecution of work in the School of Surveying is now complete. All the requisite instruments of the latest and best character are made available, and instruction will be given by Messrs. O. M. Miller and Weld Arnold, who received their training in the School of the Royal Geographical Society at London and hold diplomas from that institution. It is believed that this school now inaugurated by the Society will open an opportunity for practical training which is not afforded by any other existing institution in the country. The attention of the leading universities has been called to the facilities offered, and they have been invited to direct the attention of suitable students to the new opportunities presented.

The number of Fellows at the close of the year was 4117, of whom 408 are Life Fellows. In addition there are eight Honorary and thirty-five Corresponding Fellows.

The report of the Treasurer submitted herewith gives a condensed balance sheet and a summary of the income and expenses of the Society.

Philip W. Henry
Chairman

Report of the Treasurer for 1923

Receipts and Expenses

During the year there has been received from annual dues, interest on investments, and sales of publications	$68,626.52
There has been expended for salaries, house expenses, library, meetings, publications, postage, insurance, etc.	77,634.36
Balance charged against Special Deposit Fund	$9,007.84

Condensed Balance Sheet, December 31, 1923

Cash	$17,327.58
Sundry balances and investments	100,532.20
	$117,859.78

Capital Account, Balance uninvested	$2,610.57
Annual dues paid in advance	2,129.75
Special Fund for general purposes	90,992.16
Sundry deposits and reserves	18,350.86
Monograph Publication Fund, Balance	1,930.41
Hispanic-American Research Fund, Balance	1,846.03
	$117,859.78

HENRY PARISH
Treasurer

REPORT OF THE SPECIAL COMMITTEE

The Special Committee appointed December 13, 1923, to nominate and invite suitable persons to fill vacancies which will occur in the offices of the Society at the date of its annual meeting in January, 1924, respectfully report that they recommend the election of the following gentlemen to the office designated:

		Term to expire in
President	John Greenough	January, 1925
Vice-President	Alexander Hamilton Rice, M.D.	January, 1927
Foreign Corresponding Secretary	Professor William Libbey	January, 1927
Treasurer	Henry Parish	January, 1925
Councilors	Banyer Clarkson Edwin Swift Balch H. Stuart Hotchkiss Walter B. James, M.D. Frederick W. Walcott	January, 1927

Philip W. Henry
Roland L. Redmond } *Committee*
Hamilton Fish Kean

GEOGRAPHICAL RECORD

NORTH AMERICA

A Fault Map of California. "Earthquakes are still strange phenomena, for we have been too much afraid of them to become intimate with their causes." Thus Bailey Willis prefaces the explanatory paper accompanying the recently published "Fault Map of California" (*Bull. Seismol. Soc. of Amer.*, Vol. 13, 1923, pp. 1–12). The map is designed as a "contribution to the security of the people of the Commonwealth" by calling attention to natural conditions "in which there is an element of danger, but that danger is greatly exaggerated by ignorance and intensified by negligence." Its primary purpose is to indicate the location of faults which may give rise to earthquakes.

The map was compiled in 1922 by the Seismological Society of America in cooperation with the Hydrographic Office, Navy Department, the United States Geological Survey, the Carnegie Institution of Washington, the University of California, and Stanford University. The scale is 1: 506,880, or eight miles to the inch. The four component sheets (one bearing the title) mounted together make a wall map approximately seven feet high by six feet wide. Residents of California will find the map of considerable general value aside from its connection with the problem of earthquakes. The large scale has made it possible to show geographic details without confused crowding. Addition of the land net is a useful feature. The map is made especially attractive and usable by representation of the varied topography of the state done by John H. Renshawe, whose work in relief shading has attracted much notice for several years.

Bailey Willis and H. O. Wood are the authorities for location and character of faults, which are distinguished as "active" and "dead," represented respectively by red lines and green. Unfortunately, a uniform basis for the classification was not adopted. Mr. Wood, working in the southern part of the state, mapped in red the faults on which there has been movement within historic time and also those on which "trace" phenomena could be seen. Mr. Willis interpreted as "active" any fault apparently related to a growing mountain and took as one of his criteria the obvious displacement of an old erosion surface, whether or not the fault exhibits "trace" phenomena or has been known to move within historic time. Presumably, therefore, if the interpretation of Mr. Willis is adopted, the map gives a less complete representation of "active" faults south of San Luis Obispo than north of that point. Without doubt considerable inference and generalization was used, particularly in representing the "dead" faults; and the assurance as to location expressed by use of the full line may be questioned locally.

The outstanding fault feature is of course the great San Andreas rift, with its numerous branches. Comparison of the present map with the atlas compiled by the Earthquake Commission after the earthquake of 1906 (Carnegie Institution of Washington, 1908) suggests the great strides made in the study of the rift during recent years. There are noticeable differences in the location of the main trace on the two maps, and the rift is now shown as a complex feature, with many branches and small associated faults, in contrast to the simple line drawn in the atlas of 1908. North of Lagunitas the rift trace is now shown as forking, to straddle Tomales Bay. Except for a few small faults indicated as "dead" and uncertainly located, no lines are shown on the present map north of the latitude of Ukiah. Thus a number of large faults indicated on the older map in Humboldt and neighboring counties have been entirely omitted. No direct explanation of the omission is made, although

Mr. Willis presents the map as a statement of progress and therefore incomplete. It is to be assumed, therefore, that faults north of the 39th parallel are too imperfectly known to be represented satisfactorily.

Another striking difference between the two maps is seen in the relation of structure lines east and south of the Sierra Nevada block. In the atlas of 1908 a continuous curving fault trace is shown bounding the range on the east and south and joining the San Andreas rift near Gorman. More recently the structure of that region has been studied by Hess, Buwalda, and others, and the new map shows the main fault south of the range continuing eastward through the structural depression mentioned by Gregory and Noble as the Leach Trough (*Amer. Journ. of Sci.*, No. 205, Ser. 5, Vol. 5, 1923, pp. 229–238). Renshawe's shading brings out strikingly the abrupt regional change in topography at the fault, emphasizing the suggestion made by Gregory and Noble that this is a structure line of major importance.

The map has numerous features that inspire speculation, particularly in the field of structural geology. South of the latitude of San Francisco underwater contours, with an interval of 100 fathoms, are shown to a depth of 2000 fathoms. This contouring is based on work done by use of the new Sonic Depth Finder. The results, which are more graphically exhibited by bathymetric tints on Hydrographic Office Chart 5194, suggest a promising field of investigation. With a contour interval as large as 100 fathoms any practical study is impossible, for no doubt the most significant details are obscured. Even so the San Clemente and Santa Catalina blocks are sharply defined, and steep slopes elsewhere suggest the influence of faulting in determining the submarine topography. The canyon-like trough heading in Monterey Bay is represented as continuing oceanward to a depth of 12,000 feet! Doubtless many more data for ascertaining the significance of such features will be furnished in the near future, with extended use of the Sonic Finder.

CHESTER R. LONGWELL

The Distribution of Agricultural Exports from the United States. Agricultural produce still constitutes the major item in the export trade of the United States. For five pre-war years, 1910–1914, it averaged 48 per cent of the total; 50 per cent for 1922. A useful service has been performed by the Department of Commerce in analyzing the distribution of this export, a new statistical departure. A general survey is given in *Trade Information Bulletin No. 177*, and further details are promised in forthcoming bulletins. Products are classed in ten commodity groups—live animals, meats, animal fats and oils, bread grains (wheat and rye), coarse grains (barley, buckwheat, corn, and oats), fodders and feeds, fruits, sugar, tobacco, cotton. Comparison is made between the five pre-war years and 1920–1922.

As regards commodities the most striking change is in the relative proportions of cotton and bread grains. Cotton has dropped from 54 per cent to 32 per cent, in actual amount from 4,500,000,000 pounds to 3,250,000,000. Decline in home production has been concomitant with economic depression in the importing countries: only two, Italy and Japan, have exceeded their pre-war imports. The seriousness of this particular phase of the agricultural problem is reflected in the numerous investigations for increasing the world's supply (see, e. g., J. A. Todd: The World's Crisis in Cotton, *Foreign Affairs*, December, 1923). The bread grains increased from 10 per cent to 26 per cent (in actual amount the total of grains exported rose from 10,000,000,000 pounds to 25,000,000,000 pounds). This great gain is due primarily to the disappearance of the United States' chief competitor, Russia, to the decline of production elsewhere in Europe, and to the small crops in India in 1919 and 1920. Meats and related products have changed little in relative proportion; sugar has increased with the decline of beet sugar exports from Germany and Russia; tobacco also has increased.

As regards destination it may be said that in round numbers Europe takes four-fifths of the food exports of the United States; and of this, four-fifths again goes to the industrial region of the northwest—the United Kingdom, Germany, France, the Netherlands, Belgium—more than half to the United Kingdom (33 per cent of the total to all countries). Among changes in destination we may note the decline for Europe as a whole from 84 per cent to 77 per cent, Germany's former import of 25 per cent being cut to 14 per cent. Export to North America has risen from 10 per cent to 13 per cent; to Asia from 3.5 to nearly 7. The last may be considered indicative of a trend toward the development of a large future market for foodstuffs in Eastern Asia.

Inland Water Transportation in the United States. Under this title the Department of Commerce (*Bur. of Foreign and Domestic Commerce Misc. Ser. No. 119*, 1923) presents a critical study of the inland waterways situation in all its phases. Except for the Great Lakes, the Ohio River, and a few short routes where natural conditions and industrial development have been particularly favorable, the decline of waterway transportation has followed closely upon railroad development; so closely, in fact, that by 1895—although in the period from 1882 to 1895 New York state, for instance, had spent $125,000,000 upon the development of her waterway—those waterways had been reduced to a relatively unimportant position. It is true that much of the decline of water transportation was due to ruinous rate cutting on the part of competing railroads. This has been largely checked by prohibitions incorporated in the Interstate Commerce Act of 1887 and the Mann-Elkins Act of 1910 which amended the act of 1887. The fact remains, however, that by far the greatest cause for the decline of water transportation is due to the greater flexibility of the railroad system, to the standardization of gauge whereby transferring was largely eliminated even at receiving termini, to the greater speed and the possibility of day-and-night and year-round traffic, to greater carrying capacity of the double track road as compared with canals, to the ability to adjust the size of the train to the load and thereby reduce running costs. Of almost equal influence is the fact that, with the exception of the Great Lakes and the Ohio River, the waterways of the country do not parallel the great transportation routes. The auto truck should also be noted as a competing transportation agency of growing importance.

The factors in the problem, therefore, are many, and the eliminating of any one will not bring about a general revival of waterway traffic. Each case is a separate problem. Greater industrial concentration in certain regions may tax railway facilities to the point where waterways must be developed to lighten the congestion. The present rapid strides in the industrialization of the South and increased trade with South and Central America may give renewed prominence to the great north-and-south water routes which have been eclipsed by the trend of traffic to the Atlantic seaboard.

Variation in the Annual Discharge of Rocky Mountain Streams. Two factors contribute to the wide variation in annual run-off shown by the streams of the Rocky Mountain states (Robert Follansbee: Variation in the Annual Run-Off in the Rocky Mountain Region, *U. S. Geol. Survey Water-Supply Paper 520–A*, Washington, D. C., 1923). The influence of topography is evidenced by the fact that streams rising in the central mountain mass have a smaller range in variation than steams which rise on either the eastern or western edge of this central mountain region. Also, precipitation in any part of the mountain region depends upon the point at which the low-pressure areas cross; but, inasmuch as well-known low-pressure paths which cross the Rockies have rather wide limits, there are great

variations in precipitation and run-off throughout the mountain region in any one year and from year to year in any one section. This variation is of three sorts: the variation from year to year in any particular region; the variation among the different regions for any one year; and the variation from year to year in the relationship of the run-off in any particular region to the mean run-off for the whole Rocky Mountain region over the entire period of record (over 30 years for many stations). For instance, the lowest record, except for drainage basins in northern Montana, for the entire period covered by records occurred in 1902; and the run-off for the South Platte, Arkansas, and Rio Grande was below normal during the nineties and above normal since 1903, while the Cache la Poudre basin had low water during the eighties, high water up to 1905, and low water since then. In fact the ratio of any ten-year mean to the mean for the entire period covered by records ranges from 72 to 133 per cent. The annual run-off for streams rising in the plains east of the mountain region also varies greatly, but the records show no definite relation between precipitation and run-off. Rather, so great is the demand upon the moisture supply in the plains by transpiration of plants, evaporation, and percolation that the run-off in plains streams is governed not so much by total precipitation as by intensity. In one day in 1920 the run-off of the Cheyenne River was greater than that for the whole year of 1916 or 1919.

Erosion and Deposition in the Desert Southwest. Two conspicuous features of many arid regions are long gentle slopes, *bajadas*, extending from the base of the mountains or range of hills to the main longitudinal stream valleys or to the lake-like playas and terraces. Minor features are dunes, "desert pavements," and "pedestal rocks." Each of these features has been discussed by eminent geologists including McGee, Walther, Davis, Barrell, and Lawson, but there have been radical differences of opinion expressed thereon. Recently, however, much new light has been thrown on their origin by Dr. Kirk Bryan, of the U. S. Geological Survey, in an able discussion of their occurrence and development in southwestern Arizona. ("Erosion and Sedimentation in the Papago Country, Arizona, with a Sketch of the Geology," *U. S. Geol. Surv. Bull. 730–B*, 1922; "Wind Erosion near Lees Ferry, Arizona," *Amer. Journ. of Sci.*, No. 206, Ser. 5, Vol. 6, 1923, pp. 291–307; and "Pedestal Rocks in the Arid Southwest," *U. S. Geol. Surv. Bull. 760–A*, 1923.)

The long slopes, or *bajadas*, have two distinct phases: (1) the rock plain, named by Bryan the "pediment," and (2) the detrital or alluvial fans. Detrital materials commonly cover all but the one to three miles nearest the mountains, the thickness of the detritus increasing to the center of the *bolsón*, or great valley, where it may be hundreds of feet thick. The pediment has been ascribed to wind action by Keyes and to the retreat from the fault scarp, but Bryan believes with Lawson that it is a normal feature of arid regions studded with mountains.

Alternation of erosion and deposition is common in deserts, and hence terraces are conspicuous in many places. Davis has related these to the normal geographic cycle. Huntington, Barrell, and Visher have concluded that the climatic changes associated with glaciation probably were related to certain changes in erosion and deposition in Central Asia and Arizona. Recent terracing along the Santa Cruz Valley near Tucson was ascribed by Huntington (The Climatic Factor as Illustrated in Arid America, 1914) to recent changes of climate. From a study of tree rings he advanced the hypothesis that about 1700 the climate was considerably wetter than now. These conclusions have been considered unsound by some critics; but recent evidence, Dr. Bryan concludes, effectively supports the hypothesis. Part of the evidence is based on the recently published memoir of Father Kino who spent several years in the area about 1700 and who gave estimates of the population and irrigated land in different areas.

Dr. Bryan, in the shorter papers referred to, concludes that although wind erosion and transportation are physiographically very important in certain arid localities, in others they are insignificant. Many pedestal rocks in the southwest, commonly ascribed to wind work, are apparently the result of weathering, no clear evidence of wind erosion having been found. Likewise the frequently mentioned desert pavement is believed to be due in many places to run-off rather than to wind work, for the removal by either agency of fine materials from a gravelly sediment results in the development of a surface layer of pebbles. Furthermore, typical pavements occur where other evidences of wind work are lacking, but where the results of run-off are conspicuous. In brief, Bryan's studies have led him to conclude that running water is the chief erosive agency in nearly all parts of the southwest. Only in regions receiving less than five inches of rainfall a year and also in areas where, because of porous rocks, there is a little run-off, does the wind surpass running water as an erosive agent.

STEPHEN S. VISHER

The First Separate Map of Pennsylvania. By an important discovery Mr. Worthington C. Ford has recently identified what is probably the first separate map of Pennsylvania (see *Proc. Mass. Hist. Soc.*, Vol. 57, 1923–1924, pp. 172–181). In an eight-page tract issued by William Penn in 1681, having as its caption title "A brief Account of the Province of Pennsylvania . . . ," reference is made in a postscript to a printed "*Map of Pennsylvania*, together with a Description at the End of it." Before Mr. Ford's investigation no map had been positively identified as the one referred to in this postscript. Thomas Holme's map (see P. L. Phillips: A List of Maps of America in the Library of Congress, Washington, 1901, p. 670) was commonly supposed to have been begun in 1681, but Mr. Ford shows that it cannot have been the map mentioned in the Penn tract because it represents "a situation that must have existed later than 1681."

While examining a volume of manuscripts and printed maps in the John Carter Brown library, Mr. Ford came across "a printed map of Pennsylvania with the endorsement 'With a description' in manuscript, the very words used in *A brief Account*." "Pasted to the bottom edge of the map" he found "a statement printed in four columns, which, without a caption, is *the* description required." The map itself was one that was sold by Thornton and Seller and of which there is a copy in the Library of Congress. Phillips (*loc. cit.*) had conjectured that the date of Thornton and Seller's map was 1683, but Mr. Ford's discovery shows that it must have dated from 1681. The map "runs from New Jersey, but the detail, except for an abandoned Indian fort, called Susquehannah fort, and names on the west shore of Chesapeake Bay, ceases with the Susquehannah River. Thus only some sixty miles to the west of the New Jersey line and some eighty-two miles from north to south are given with names. The designer or engraver has sprinkled hills and trees in the unoccupied spaces, each tree being named." In various respects the map differs from that of Holme. Unlike the latter, which "is frankly extended to show the location of Philadelphia, how the place was laid out and the grants of land made to individuals," "the map of 1681 was in anticipation of settlement, showing neither Philadelphia nor its proposed site and sparing such detail as crowds the Holme map."

The text of the "Description" (given in Mr. Ford's paper) "is that of *A brief Account* shortened and modified to suit the smaller space of the form of printing." The country, its produce and inhabitants, conditions of settlement, and persons fittest for plantations are briefly discussed, and recommendations are given for the journey and in regard to what should be first done on arrival. The southerly latitude of the region in comparison with that of England is commented upon, but it is added: "The Air is generally clear and sweet, the *Summer* is longer and Hot-

ter, and *Winter* shorter and Colder than in *England:* The Soil is said to be as good as any in those parts." The capabilities of the country are estimated optimistically: "It is thought by several knowing Persons, that have Travelled those parts of *America*, and have been well acquainted with places in *Europe* of the same degree, that there may be *Silke, and Wine*, if not *Oyle;* and for *Flax, Hemp, Woad, Madder, Liquorish, Potashes, and Iron*, there needs to be no question." In conclusion the remark is made that "it seems to many, to be the time wherein those desolate Western parts of the World are to be Planted, and have their day, as *Asia, Africa,* and *Europe* have had, (of which there are divers prouisees extant) yet let all have a Reverend regard to Gods Providence in their removal, and be serious in it, rather seeking the comforts of retirement, and sufficiency for Life (like the blessed Patriarks of Old,) then ease, fulness and wealth. . . . "

EUROPE

The Forests of Northern European Russia. It seems inevitable that in the near future the industrial nations of northwestern Europe will be obliged to draw their supplies of soft wood to a large extent from the immense and almost untouched forests of northern Russia. The resources of Scandinavia and the Baltic states are barely sufficient to meet the demands now placed upon them. Hitherto the United States and Canada have exported great quantities of timber and its products to Europe, but the United States will soon be eliminated. During the next half century most of the Canadian exports will find their way southward to satisfy our ever increasing demand. Britain, France, and Germany will have to seek in Russia the timber they formerly received from North America.

E. P. Stebbing, professor of forestry at the University of Edinburgh, visited Russia in 1917 in order to investigate on the ground the northern forests and to determine through conversations with members of the Provisional Government, then in power, the most satisfactory measures toward rendering the resources of these forests available to Great Britain at the lowest cost. He discussed his investigations and certain general recommendations based upon them in a paper read before the Royal Society of Arts in March, 1923 ("The Forests of North Russia and Their Economic Importance," *Journ. Royal Soc. of Arts*, Vol. 71, 1923, pp. 416–429). His recommendations envisage the obtaining by Great Britain—when the political situation in Russia permits—of concessions of half a million acres of forest land in the Olonets government, of a million or a million and a half in the Vologda government, and of a million acres in the Ob forest area to the east of the Ural Mountains. On her part, Russia will find a ready means toward economic rehabilitation if she permits the exploitation of her forests through foreign capital. Work could be started in the forests without delay, whereas much time must elapse before agriculture and industry can be revived to a condition of large-scale productivity.

From the geographical point of view, Professor Stebbing's paper and an earlier one by him ("The Forest Region of North-East Russia and Its Importance to Great Britain," *Geogr. Journ.*, Vol. 51, 1918, pp. 359–374) present the latest available account in English of the forests and forest life of a region very little known to the western world.

With the exception of the tundras along the Arctic coast, the whole of northern European Russia is forested. "The forests in the Olonets Government [the vicinity of Lake Onega] contain small trees for the most part, serviceable for wood pulp manufacture." Vaster virgin forests lie to the eastward in the Vologda and Archangel governments. The valleys of the Mezen and Petchora Rivers "contain fine forests without a doubt, especially the former;" but of all this region,

both in the wealth of the timber resources available and in the facility of communications the most promising tracts lie in the basin of the Vichegda.

The town of Ust Sisolsk, on the Vichegda 400 miles above its confluence with the Dvina, is in the center of a district "which contains nearly 36,000,000 acres of forest [slightly less than the area of Michigan], some of it reported by those who were in the best position to know, to contain as fine timber as was to be found anywhere else in Russia. Already, although but a fringe had been tapped, over half a million logs were floated down the river yearly from Ust Sisolsk, in addition to those brought out down the tributaries between that town and Kotlas." The logs are sent down the smaller streams singly; on reaching the larger rivers they are made into rafts which are easily piloted down the Vichegda and Dvina to Archangel.

The sparse population of the Vichegda basin is composed for the most part of Zyryans (see map in this number of the *Review*, p. 271), "a light-hearted, singing people, fond of bright colours in dress, and very different from the dull, stolid North Russian peasant." These folk speak a language of their own—a mixture of Russian and Samoyed—and dwell in villages scattered along the thin ribbons of cultivated land that fringe the rivers. Back of these narrow strips the forest prevails, uninhabited except in the winter. Only through the combination of summer work on their fields and of winter work in the woods are the natives able to "continue to inhabit these regions under modern conditions of life, primitive as they still are in these parts."

The Kola Peninsula. The Murman Railway, which has given Russia the use of a new ice-free port, has also opened a great stretch of almost unpopulated country to exploitation and settlement; but without local population, production, and trade it is safe to say that this whole enterprise must remain unprofitable and insecure for the nation. To investigate the possibilities of the region, and especially of the Kola Peninsula, which forms the hinterland of the Murman Coast, the Northern Scientific-Industrial Expedition was despatched in 1920, including a soil and botanical detachment from the Geographical Institute of Petrograd. The findings of this detachment are embodied in six reports, three of which have so far come to hand.

It must be admitted that the conditions described in these reports hold out little hope as to utilization of the soil of the region. Its topography presents the characteristics of recent glaciation, with a thick deposit of glacial drift almost entirely covering the bed rock of crystalline schist. The climate is subarctic, with about four months of temperate weather and with slight rainfall. The vegetal associations of the interior are mainly those of the temperate zone—pine, fir, and birch forest and sphagnum swamp. The latter merges into arctic tundra, the report on which is not yet available. The investigators appear, however, to use this term in a very restricted sense; for Professor G. I. Anufriev, in his report on swamps, describes a formation in which hummocks retain cores of ice the year round as "transitional." He writes, with regard to previous studies of arctic vegetation, "the greater part of the work done bears mainly upon the purely tundra formations, neglecting the forest zone adjoining them on the south: . . . this must, unfortunately, be said to apply even more strikingly to the swamps." His report indicates few possibilities of exploitation. The peat of these northern swamps is not even suitable as fuel, owing to insufficient decomposition. The most practical suggestion is that of their conversion into forest by drainage.

The two associations noted give rise to two main types of soil: the peat of the swamps and the *podzol* of the forests, the latter of which is interestingly described by E. A. Marcus. Neither is susceptible of cultivation in its existing state, be-

cause of extreme acidity due to the total absence of limey soils. Professor Sukachev, in his introductory report on general problems, makes the observation: "There is no doubt that the question must soon be faced of developing by selection new races of cultivated plants adapted to the conditions of the far north." But there seems little immediate prospect of any utilization of the soil of the Kola Peninsula otherwise than through forestry.

J. V. Fuller

Postglacial Changes in European Russia According to the Present Distribution of Birds. Under this title, V. V. Stanchinski publishes, in the 1922 number of *Izvestia*, of the Geographical Institute, a preliminary account of the present distribution of birds in Russia as affected by past conditions. Noting that many species of swamp and forest birds of other regions are not now to be found in central Russia, despite favorable conditions, and that they even avoid the region in migratory flight, the writer seeks an explanation for their absence in the former existence of conditions unfavorable to their spread. In his classification of the kinds of frontiers limiting the spread of species, he includes a category of "relict" frontiers, determined by conditions which have changed so recently that their effects have not yet been overcome by the more slowly spreading species. With respect to numerous swamp and forest birds, such a "relict" frontier appears to exist round the region of central Russia extending roughly from the Vistula on the west to the Volga on the east and from a line through Kiev on the south to a line through Novgorod and skirting the Baltic on the north. Within these frontiers, the writer concludes, there must have been "in postglacial times, a rather lengthy period during which swamp, water, and forest birds could not spread into central Russia."

Such desert conditions could hardly have followed immediately upon the withdrawal of the ice. Moreover, various species of tundra and woodland birds are found to migrate across the region, although conditions of life there are not now favorable for them. From this fact and from the writer's assumption that "every migratory route must . . . be considered as . . . retracing the spreading of the species" the conclusion follows that, in past times, favorable conditions did exist. These would naturally have intervened between the glacial and desert periods. The further supposition of a transitional period between the desert and the swamp forest of the present time is borne out by the particular rarity of birds requiring swampy conditions, even in such favorable regions as the Novgorod and Kostroma governments.

On the basis of these deductions the writer outlines the following succession of postglacial periods in central Russia: "(1) Lake-tundra (arctic); (2) Meadow-forest (birch-aspen woodland); (3) Desert-steppe (central Russian desert); (4) Forest-steppe; (5) Forest (*taiga*)." While such a reconstruction of postglacial changes can hardly be taken as established by this one line of investigation, the possibilities should tempt further inquiry.

J. V. Fuller

The Gradual Filling In of the Crater of Vesuvius. After the eruption of 1906 the crater of Vesuvius measured some 700 meters in depth and 720 meters in width along the major axis. Since that time the depth has been diminished considerably more than half by a gradual process of filling in. The successive stages in this process have been carefully observed and measured by Italian scientists and are discussed (to 1921) in a paper read by Professor Alessandro Malladra before the Eighth Italian Geographical Congress at Florence, 1921 ("Sul graduale riempimento del cratere del Vesuvio," *Atti VIII Congresso Geografico Italiano*, Vol. 2,

Florence, 1923, pp. 67–75). Figure 1 reproduces on a smaller scale an idealized cross section which accompanies Professor Malladra's paper and illustrates graphically the chronological sequence of events.

The filling up process until 1920 may be divided into two phases. During the first phase, which lasted until 1911, strictly volcanic activity was dormant. Landslides from the over-steepened walls were continuously pouring loose materials into the funnel-shaped crater until the latter was reduced to a maximum depth of some 300 meters. Between 1911 and 1913 the topography of the floor of the crater "underwent notable changes in form and oscillations in altitude." Whereas ma-

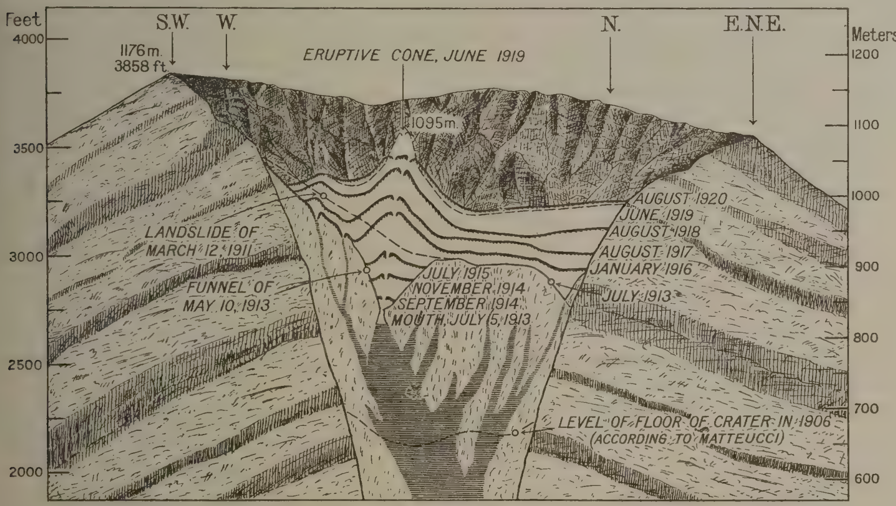

FIG. 1—Crater of Vesuvius. Ideal cross section passing through the eruptive cone showing successive phases in the filling in of the crater from 1906 to August, 1920. After A. Malladra.

terials from the landslides were still being contributed from above, volcanic activity was manifest in the depths of the mountain. The unconsolidated deposits immediately beneath the crater were being melted by contact with uprising magmas, and their resulting loss of volume produced subterranean caverns. When the roofs of these caverns collapsed, folds and funnel-shaped hollows appeared on the surface of the crater floor. On July 5, 1913, molten lava actually came to light at the bottom of the deepest of these hollows, forming what the Italians style a "mouth of fire" (*bocca di fuoco*).

This event ushered in the second phase, one of active volcanism. Since 1913 there has been an intermittent building up of the crater floor by successive flows of lava and dispersals of volcanic *ejecta* at times of more pronounced activity. Outpourings of lava, however, have contributed the greater quantity of material. Some of the lava has found its way to the surface through lesser channels and fissures, but by far the larger part has been derived from the "mouth of fire" which originated on July 5, 1913. When a semi-liquid substance wells up vertically from an aperture and hardens rapidly, as does lava, there is a tendency toward the building of a cone around the aperture. The main eruptive cone of Vesuvius grew almost vertically until a maximum altitude was reached in June, 1919. In addition to this main cone, secondary cones have grown to lesser heights around apertures of secondary importance.

Vesuvius has been active since the period covered by Professor Malladra's paper. The eruptive cones, especially the principal one, have been materially modified

in form and height. For example, in October, 1921, the main cone was observed to have been split open and a great mass of lava to have issued forth and covered practically the entire floor of the crater. On March 12, 1922, the height of the main cone was about 80 meters: by May 18, 1922, it had been reduced to 25 meters. The general level of lava accumulations in the crater has also been progressively raised by continued fresh flows (see R. Zünckel: Beobachtungen im Vesuvkrater, *Zeitschr. für Vulkanologie*, Vol. 6, 1922, pp. 258–261).

Recent Investigations of the Currents of the Western Mediterranean. A widespread belief has prevailed that a fairly steady current (known by the Italians as the *litorale mediterranea*) moves in a northwesterly direction along the west coast of Italy. This belief has even found its way into navigation manuals. Experiments carried out by Professors G. Dainelli, O. Marinelli, and G. Stefanini in 1909–1910 and by Professors Baldasseroni and G. Stefanini in 1919–1920 have shown that the conception is misleading.

The method of experimentation was one that has often been employed in oceanographical research. Bottles were thrown into the sea a few miles offshore near Leghorn. Each bottle contained a blank form which the finder was requested to mail back to the investigators after he had filled in the date and place where the bottle was found. Of 127 such bottles employed in 1909–1910 no less than 75, or 59 per cent, were recovered. In 1919–1920 340 bottles were used, but only 97, or 29 per cent, of these were heard from. In each case a few bottles at a time were set afloat at intervals throughout an entire year, in order to determine the variations in currents from season to season.

The researches of both 1909–1910 and 1919–1920 tended to show that during the winter half-year there is generally a counterclockwise movement of the waters of the western Mediterranean, governed by the winds flowing towards an area of low barometric pressure prevalent there at that time of year. On the other hand, the conclusions drawn from the two sets of experiments for the summer half-year were not the same. The observations of 1910 indicated a distinct reversal in the direction of the drift, but those of 1920 gave no such evidence: they showed that the seasonal uniformity (for that particular year, at any rate) was much less marked. Most of the bottles in 1919 were found either off the coast or along the Italian seashore north of Castiglioncello where they were launched. Some, however, were carried to the shores of France, Spain, the Balearic Isles, and even Algeria and Tunisia.

Though the experimenters do not maintain that their work has resulted in a definitive understanding of the problem, both sets of experiments have shown that the movements of water in the western basin of the Mediterranean are extremely variable, changing in direction and velocity with the changes of the winds. There is certainly no well defined, perennial current corresponding to the older conception of the *litorale.* (See *Materiali per la conoscenza del Mediterraneo IV: Esperienze sulle correnti nel Tirreno*, *Memorie Geogr.* (Suppl. to *Riv. Geogr. Italiana*) *No. 22* (= Vol. 7, pp. 195–241), Florence, 1913, and *Atti VIII Congr. Geogr. Italiano, tenuto in Firenze dal 29 Marzo al 6 Aprile, 1921*, Florence, 1922–23, Vol. 2, pp. 185–194.)

London: A Geographical Synthesis. The geography of a major city is yet to be written. The work is too large for a single hand, because the range of influences that shape a metropolis is too wide to be comprehended by a single mind. The problem of London, however, is being attacked from different sides, all offering material which geography should soon weave into a unified interpretation.

Recent work, dependent on voluminous and scattered sources, has revealed the geography of London in its broad outlines, at any rate up to the Tudor period. Modern London as a whole is too intricate in its subordinated geographic relations

to reveal them yet. The bridgehead occupied by the Romans, where the tidal estuary of the Thames narrowed to negotiable width, is a point which has proved and realized a series of unsuspected advantages that have made every step progressive. In manifold ways the position has suited England, and the world's trade with England, to the subordination of all rival positions. It has moreover proved itself easily adaptable to every increase in the volume of that trade. London, then, is primarily a port. It is also the center of administration and finance, thus executing for England in one place the work done by Rotterdam, The Hague, and Amsterdam for Holland. Sir Joseph G. Broodbank has described the evolution of the port in a truly geographical manner (History of the Port of London, 2 vols., London, 1921). London overcame its most serious disadvantage, the treacherous channels of the estuary, in early times. Between the Conquest and the reign of Henry II the embankments were built by unknown hands for irrelevant purposes. The channel was reduced to one tenth of its width and by tidal scour, unaided, has cleared itself for shipping. From the hithes of the Saxons to the later basins and docks (primarily intended only for the fitting of vessels), through the great dock-building period of the first decade of the nineteenth century when the demands of sailing ships were met, to the subsequent dock extensions for steamers, starting in 1850, the author shows the port in continual growth and says gently that "London is about sixty miles from the sea, i. e. about the distance which an ordinary steamer can cover while the incoming or outgoing tide lasts."

Early London was ruled by its topography. Hilda Ormsby (London on the Thames, London, 1924), has made a big contribution here by providing a contour map of the London region compiled from all available data, no surveyed contour map being in existence. She shows that the size of the *city* of London has been fixed since Roman times by the walls which were erected along the natural line of defense. She gives attention to such important matters as water supply, the evolution of city drainage, the extent of made ground, the evidence of modern drilling, the rivalry of London and Westminster, and the commerce of the city as distinguished from the port traffic.

If early London depended on its topography, the growing town of the Middle Ages was controlled by its geology. This is well shown by C. E. N. Bromehead (The Influence of Its Geography on the Growth of London, *Geogr. Journ.*, Vol. 60, 1922, pp. 125–135). The absorbed villages were mostly placed on water-bearing strata, and the expansion of London took place on the water-bearing Thames gravels overlying the impervious London clay. Potable water was obtainable at a depth of 25 feet, and, until the supply became inadequate and contaminated, it was used exclusively. Here we find London overcoming geographical control. Bromehead and Ormsby both describe the supplementing of the supply by the placing of a waterwheel at London Bridge, then by leading conduits into the city from distant sources. Dr. Morley Davies, in a lecture delivered in London on November 28, 1923, of which we have received a summary, has added further details to this aspect of the geography of London from his own researches on metropolitan hydrology. He also discusses the influence of the river terraces on the growth of the city.

In an historical statement largely concerned with the development of city government William Page (London: Its Origin and Early Development, Boston and New York, 1923) has done great service in providing an account of the administrative boundaries of the city. In late Saxon time the city was divided into "sokes," districts over which private jurisdiction was exercised. These were city fiefs entailing military obligations of defense. From them arose the wards, likewise originally with defensive duties. The parishes seem to have been independent units—a contrast with the rural order of relations. The author suggests also an indication of a critical stage in the peopling of London when he states that "those who in the twelfth cen-

tury wished to find sites for the foundation of new religious houses or for building themselves mansions with grounds, had to seek for land outside the walls" (p. 179). London within the walls was a fully occupied space. Suburbs were growing and were limited by bars on the highroads. Ormsby shows that they grew first on the common lands. Not until the dissolution of the monasteries, when great suburban expansion took place, were they able to spread over ecclesiastical lands.

The aspect of London at various periods may easily be conceived from the illustrations given by Broodbank and Ormsby, but more is available. The city preserves its past and can show actual monuments from which the aspect of past periods can be deduced (G. B. Gordon: Ancient London, [*Univ. of Pennsylvania*] *Museum Journal*, 1922, pp. 177–237 and 257–399).

In comparing the works discussed here, it is not surprising, in view of the vast material involved, to find small discrepancies of scholarship. For example, Page considers that the Saxon street system evolved with little regard to the Roman (pp. 31 and 267), whereas Bromehead states that many Saxon churches faced Roman streets (p. 130). Except for the Saxon period, however, the geography of early London is now comparatively clear. For the much more difficult period since Tudor times a splendid base exists—the Ordnance Survey map in 20 sheets, on a scale of six inches to one mile.

AFRICA

Chronological Records of the Nile Floods and Changes in the Nile Delta in the Middle Ages. Students of climatic cycles will be indebted to Prince Omar Tussun for translations of two medieval Arabic documents throwing light on the history of the floods of the Nile. One of these is a table by Abū'l Mahāsin (1470 A. D.) showing the *maximum* and the *minimum* level of the river (presumably as indicated by the Nilometer at Cairo) for every year of the Hegira from A. H. 20 to A. H. 855 (*i. e.* 640–1451 A. D.). The other is a descriptive chronological table from a work of Ibn Iyās (1524 A. D.) recording all the important floods of the Nile and their consequences from 769 to 1517 A. D.

It is unlikely that there has been any radical and progressive change in the climate of Egypt since a very early period. The bulk of evidence would seem to show that in the time of the Pharaohs and Ptolemies the country was quite as arid as it now is and that the inundations of the river behaved much as they do at the present day (see Hermann Leiter: Die Frage der Klimaänderung während geschichtlicher Zeit in Nordafrika, *Abhandl. K. K. Geogr. Gesell. in Wien*, Vol. 8, 1909, No. 1, pp. 95–100; Leo Berg: Das Problem der Klimaänderung in geschichtlicher Zeit, *Geogr. Abhandl. herausg. von A. Penck*, Vol. 10, No. 2, Leipzig and Berlin, 1914, pp. 62–64). Abū'l Mahāsin's and Ibn Iyās' figures will probably not give any evidence to upset this assertion. On the other hand, if plotted in the form of graphs, these figures should provide a clue to the understanding of periodic oscillations in rainfall in the equatorial regions where the Nile takes its rise. Such graphs would well repay critical comparison with the climatic data furnished by the medieval chronicles of Europe as tabulated by Arnold Norlind (Einige Bemerkungen über das Klima der Historischen Zeit nebst einem Verzeichnis mittelalterlicher Witterungserscheinungen, *Lunds Univ. Årsskrift*, N. S., Section 1, Vol. 10, No. 1, 1914) or with the record of oscillations in climate provided by the study of tree rings (see A. E. Douglass: Climatic Cycles and Tree-Growth, *Carnegie Instn. Publ. No. 289*, Washington, 1919).

The tables of Abū'l Mahāsin and Ibn Iyās are given in a monograph by Prince Omar Tussun entitled "Mémoire sur les anciennes branches du Nil: Époque arabe" (*Mémoires Presentés à l'Inst. d'Egypte*, Vol. 4, Cairo, 1922–1923, pp. 65–213; reference on pp. 135–170. The first part of this "Mémoire" on the ancient epoch

was published in 1922 as Fascicule 1 of the *Mémoires*, etc., Vol. 4, and was noted in the *Geogr. Rev.*, Vol. 13, 1923, pp. 618–619). This monograph as a whole treats of changes in the Nile Delta as recorded by Arabic authors from the ninth to the sixteenth centuries of our era: special chapters are included on the history of the Alexandrian canal and of the canal from Cairo to the Red Sea.

At no time during the entire Arab epoch did the Nile reach the sea through more than three primary outlets. During the first century after Christ there were said to have been no less than twelve outlets, seven of which were of primary importance. In the Middle Ages the Canopic and Pelusiac branches, which in antiquity bounded the Delta on the west and east respectively, had dried up. The only outlets mentioned by all the Arabic authorities quoted by Prince Omar were the Rosetta and Damietta branches. The number of distributaries by which the river reaches the sea and of canals by which its waters are carried through the delta may be regarded as an index of the economic prosperity of the region. Widespread distribution of the life-giving waters is both a cause of greater fertility and a result of the prosperity to which such fertility gives rise. Negligence in the maintenance of the canals during the Middle Ages may be attributed to "political causes and to the continual changes in the government which directed the destinies of the country."

ASIA

Rivers and Settlement in the Indo-Gangetic Plain. "A land of deserted cities" is the essence of Mr. W. H. Arden Wood's paper "Rivers and Man in the Indus-Ganges Alluvial Plain" read before the British Association Meeting, 1923, and published in the January (1924) number of the *Scottish Geographical Magazine*. In northern India the relation between the rivers and human settlement is ancient and intimate. As Vidal de la Blache put it in his analysis of the population distribution of that country, "le rôle de l'eau est donc prépondérant." On the Indo-Gangetic plain one of the most important elements in that relation is the constant change in the river courses—"from year to year and from age to age." The surface of the great flood plain is everywhere seamed with old river channels which are themselves but representative of others obliterated by nature or man. Every such channel signifies a dislocation of human occupation. In the Punjab the lines of mounds marking abandoned villages are so common as to be described by a special term, *theh*. Other causes of course have been operative in the decline of cities and villages of the plain, but none on such a broad and continuous scale. Some ancient cities, such as Benares and Patna, have enjoyed a long continuous existence because of their location on hard clays or the nodular limestone that is an exceptional feature of the fine, easily eroded waste of which the plain is built. For a reconstruction of the physical history of the plain the cities furnish perhaps the most valuable criteria, for they constitute fixed points of reference to which may be applied knowledge from tradition and from the historian and chronicler.

Instances from early and late times are given by Mr. Wood. A special interest attaches to that of the now riverless gap between the Sutlej and the Jumna. The region is the scene of early Aryan occupation and a center whence that culture spread. Climatic change has been invoked as a cause of the approach to desertic or semidesertic conditions, but a sufficient explanation may be found in hydrographic change. Through the region may be followed traces of an old river channel, approximately paralleling the courses of the Sutlej and the Indus to Sind and thence to the Rann of Cutch. It is known as the Hakra. If the Sutlej was its feeder, as certain evidence seems to indicate, the diversion of this notoriously changing stream (the Sanskrit name means "dreadful") to the Punjab system would account for the drying up of the Hakra.

Coming down to the present we find the opinion expressed that "the very existence of Calcutta, not as a port, but as a habitable city, is threatened by the decline of true deltaic conditions in its vicinity." The history of the Ganges delta is in some ways abnormal. The rule that in the northern hemisphere southward-flowing streams tend to advance westward (rotational deflection) is reversed. The Ganges delta from centuries ago has advanced eastward, presumably because of changes of level in the delta, and in the sixteenth century the main Ganges moved eastward to occupy the bed of a smaller stream, the Padma. The western distributary, the Hooghly, which is the sacred branch, has now reached a stage where it is ceasing to function as a live river. Trading settlements above Calcutta flourishing in the sixteenth to eighteenth centuries are extinct as seaports, and though Calcutta is not threatened in this way—so long as the channel is kept clear by the strong tides and scouring action of the freshets of the rainy season—fears are entertained regarding its hygienic state. Calcutta was a very unhealthful city until the present drainage system was established at considerable cost in the latter half of the last century. The drainage is towards a local deltaic channel, the Bidyadhari, which is rapidly silting up.

POLAR REGIONS

The Ross Dependency: A Territorial Addition to New Zealand. With her mandate in Samoa (awarded in 1919) and the recent allocation of the Ross Dependency (August, 1923) New Zealand's territorial jurisdiction is far spread. The procedure by which the Ross Dependency was created (Order in Council) is described in the *Geographical Journal* (November, 1923) and compared with that followed in the case of the Dependencies of the Colony of the Falkland Islands, 1908 and 1917 (Letters Patent).

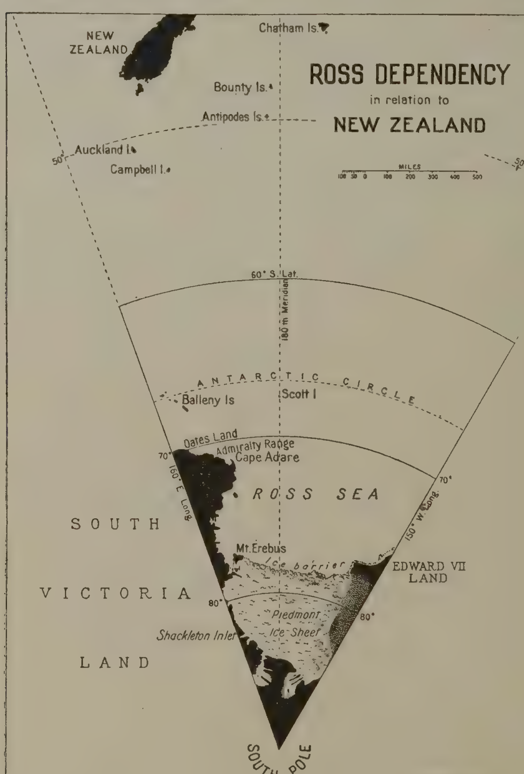

Fig. 1—Map of the Ross Dependency.

The Ross Dependency comprises portions of the Ross and Victoria Quadrants of the Antarctic continent. It is officially defined as "all the islands and territories between the 160th degree of east longitude and the 150th degree of west longitude, situated south of the 60th degree of south latitude." The sector includes Edward VII Land, discovered by Scott; the great ice barrier now known as the Ross Piedmont; the Ross Sea; and the façade of South Victoria Land. The coast has been fairly well charted, but two comparatively large areas remain unexplored — the Admiralty Range with its hinterland as

far as Oates Land and King Edward VII Land with its hinterland (H. T. Ferrar: History of Ross Dependency, *New Zealand Journ. of Sci. and Technol.*, Vol. 6, 1923, pp. 205–208). Possession was first taken by Ross in 1841, and the area is known through the successive explorations of the last quarter-century—especially Scott's first and second expeditions and Shackleton's first expedition.

The New Zealand government receives the dependency free of cost. It will issue licenses for whale and seal fishing in the seas of the new dependency.

HUMAN GEOGRAPHY

Overpopulation: The Limitations of an Idea. The word "overpopulation" is in current public use. It expresses conditions of discomfort in certain communities, connected in the public mind with a belief that the number of inhabitants has become excessive. Its loose and vague use has almost stripped the term of scientific value. So intricate are the connections between social conditions and numbers, that it is difficult to state when and why numbers are excessive. Nevertheless, the public mind has discerned a possible or real social condition. It is the duty of social science to investigate and define it.

An attempt has already been made in these pages to give definite meaning to the term (*Geogr. Rev.*, Vol. 13, 1923, p. 282). Mr. J. Lionel Tayler removes an element of confusion in pointing out that "overpopulation" is distinct from "overcrowding." The latter condition is easily definable in scientific terms. He suggests that those who speak of overpopulation mean "that human beings are *in the mass* at the limit of their powers [to make use of available resources], and there is no reasonable prospect of an improvement of them for a century or two; hence an increase in population, as the present methods of industry would not be greatly improved, would be dangerous" (J. L. Tayler: Overpopulation, *Sociological Rev.*, Vol. 15, 1923, pp. 235–236). Sir William H. Beveridge indicates a further limitation. He shows that in England from the evidence of past experience, especially that of 1879 and 1886, the ratio of unemployment is not an index of overpopulation (W. H. Beveridge: Population and Unemployment, *Nature*, No. 2815, Vol. 112, 1923, Oct. 13, pp. 548–550; *idem:* Population and Unemployment, *Econ. Journ.*, Vol. 33, 1923, pp. 447–475). He goes further, in criticism of J. Maynard Keynes, and shows that in Europe, in the period 1880–1920, the yield and per capita production of food crops and certain raw products increased steadily with increase of population. This means little without an examination of the all-important rates of increase, which he does not make. He also shows that the real cost of corn fell during the period, in England, and that steady progress was made in material production. His conclusion is that the British outlook need not be clouded but that the population problem, owing to inevitable great increase, remains for the future. Keynes makes effective reply (J. M. Keynes: A Reply to Sir William Beveridge, *Econ. Journ.*, Vol. 33, 1923, pp. 476–486). He produces statistics that relate better to the problem than those used by Beveridge and shows that the British relation of the volume of manufactured export given for a uniform quantity of food import improved steadily to about 1903, after which it deteriorated. The manufactured exports of Great Britain "are now buying *in the aggregate* about 12 per cent less foodstuffs than before the war." This suggests that a higher standard of life could be maintained if there were fewer to employ and to feed. If this be true, numbers are already inimical to standards of life in Great Britain.

From Germany comes a very earnest and detached study of the matter, surprising indeed when one recalls the German policy of fecundity (Ottokar Landwehr: *Übervölkertes Land:* Eine bevölkerungspolitische Studie über Gegenwart und Zukunft Europas, Vienna and Leipzig, 1923, 59 pp.). It says little that is not available in English, being indeed a general statement of the population problem

in terms familiar to American students; but its tone and source give it importance. Landwehr assumes that France exhibits the desirable condition. He regards 100 persons a square kilometer as the average limit of occupation. With this standard of reference, he has compiled a table showing the overpopulation and underpopulation of the countries of Europe. He regards Europe, except Spain, Russia, and the Balkan regions, as overpopulated, Germany and England excessively so. His remedy is a more even distribution, starting at home, to be followed by emigration, with Russia as the receptacle for German overflow.

Switzerland is the classical example of an "open" population—one dependent on the import of fundamental necessities and getting them by the export of manufactured "equivalents". Julius Weyler interprets the present condition of the Swiss in the light of the past (Das Ubervölkerungsproblem der Schweiz, Separate from *Zeitschr. für Schweizerische Statistik und Volkswirtschaft*, Vol. 59, 1923, pp. 3–39). People engaged in the manufacture of equivalents form an "excess" population. We may speak of overpopulation only when the equilibrium between the capacity and the size of a population must be restored by restriction of its growth or modification of its constitution. Those processes directed towards diminution express overpopulation only when their connection with an economic basis insufficient for existing needs is demonstrable. Weyler's argument is involved but shows well enough that the trend of Switzerland from the Middle Ages has been from decreasing overpopulation to increasing excess population. The Swiss have found it profitable to develop their rural effort into high-grade dairy production and that of their handicraft into refined manufacture, like ribbon weaving, embroidery, and the making of instruments. They sell their goods to buy their food. The country thus reacts sensitively to changes in the outside world. The war on the whole proved favorable, many products being in high demand, but the peace has brought a reduction of the purchasing power of customers. Hence a period of overpopulation is pending. The economic basis of food will be insufficient. The consequences of war in Europe have had the same effect in the past. The condition will be met by increased death rate, decreased marriage and birth rates, and by emigration—the reduction of unnecessary numbers by all suitable means.

The war left Vienna and Petrograd overpopulated. They have lost since the war 0.46 and 1.26 million people respectively (Landwehr). The national economic needs that rendered necessary the presence of the former numbers at both places have diminished greatly. The past numbers are no longer required there and in consequence cannot be maintained. No place which requires the presence of large numbers in order that the life of a population group may proceed normally is overpopulated as long as a mechanism for feeding them can be maintained. Whatever be the conditions of overcrowding or unemployment of part of the community, equilibrium of population will exist as long as economic processes call and keep the numbers there at the average standard of life of the group. Standards must be maintained. "Recoil from standards once reached is the gesture of a community touched by decay" (Beveridge).

Recent Studies in the Geography of Coal Resources. The question of the exhaustion of the world's oil resources is one of immediate economic importance: on the other hand the date of the ultimate exhaustion of the coal reserves is, at the present time at least, more or less an academic question. Though the figures quoted vary widely, in any case there probably is sufficient coal to last several centuries even in those countries that are less well endowed. More serious and immediate problems are presented by the geographical circumstances of the various coal fields—their positions in relation to markets and to political frontiers—and, in the economic field, by the control of output and distribution. Some of the

more important of these problems are clearly explained by Dr. Walter S. Tower in an article entitled "The Coal Question" (*Foreign Affairs*, Vol. 2, 1923, pp. 100–116) and in a booklet by Professor A. J. Sargent, "Coal in International Trade" (London, 1922).

The three greatest coal reserves in the world are to be found in China, western Europe, and eastern North America. The Chinese reserves at the present time are virtually nonproductive and far removed from the industrial centers of modern civilization. The coals of western Europe lie in two primary areas each productive of a surplus of supply: Germany and Great Britain. Prior to the World War these two areas between them were able to supply the demands of the remaining "deficit" areas of Europe, and British coal was also furnished to South America without meeting competition. The dislocation of the economic structure of Europe as a result of the war and the tremendously enhanced costs of production have thrown out of adjustment the delicately balanced international coal trade. During 1920 and 1921 American coal was actually sold in Europe itself at lower prices than British coal, and this despite the serious geographical disadvantages under which America labored. The cost of producing a unit quantity of coal in America is so much less than in England, that the expense of carriage from the mines of Pennsylvania and West Virginia to the sea at Hampton Roads and thence to Europe failed to raise the price of American coal to the British level. Though American competition has not been maintained in Europe since 1921, its revival is an ever-present possibility, a possibility that can only be met by rigid economies in all phases of British production.

About half of the total coal reserves of the world exists in the form of coals of low grade, brown coals and lignites, containing large percentages of water and low percentages of carbon. In order that these may be made serviceable for industrial purposes they have to undergo the somewhat elaborate process of drying and conversion into briquettes. Before the World War brown coals were mined and briquettes were manufactured on a large scale in Germany and Austria, and now Germany is reported to be producing nitrogen products from lignites on a commercial basis. Their use was little known in the United States and the British Empire, but as the cost of extracting bituminous and anthracite coal increases the time will inevitably come when the Anglo-Saxon nations will have to turn to these inferior grades. They are present in abundance in the United States, about one-third of the total estimated coal resources of this country consisting of lignites in Texas, Alabama, the Dakotas, Montana, and Wyoming (see W. A. Bone: Brown Coals and Lignites, *Journ. Royal Soc. of Arts*, Vol. 71, 1923, pp. 172–184, 189–199, and 208–216; *U. S. Bur. of Mines Technical Paper 178*).

While the "Coal Resources of the World," the well-known work based upon investigations made on the initiative of the executive committee of the Twelfth International Geological Congress which met in Canada in 1913, remains the fundamental quantitative study of the coal resources of the world, its reports must be used with caution. Exploration of coal reserves has made notable progress since they were published. Furthermore, the data included in the reports themselves and the manner in which these data are presented have not escaped criticism. It has been pointed out that the classification of coals according to their chemical analyses is of little significance from the practical and industrial points of view and that a better classification might have been made if geological ages had been used as the criteria. More serious has been the charge that the various contributors failed to maintain uniform standards in estimating reserves, thereby rendering the statistics of doubtful validity when employed for purposes of comparison. The reports of most countries draw a distinction between "actual" reserves, "including cases in which the calculation of the amount is based on a knowledge of the actual thickness and extent of the seams," and "probable" reserves, "including

cases in which an approximate estimate only can be arrived at." This important distinction was not made in the report of the United States, the country with the greatest reserves.

These and other observations regarding the "Coal Resources" are expressed by Dr. F. Frech in a volume entitled "Die Kohlenvorräte der Welt" (*Finanz- und Volkswirtschaftliche Zeitfragen No. 43*, Stuttgart, 1917). Dr. Frech discusses the world's coal reserves country by country. In want of other sources upon which to draw, much of his material was taken from the reports of the Canadian congress, though these reports were throughout subjected to severe criticism. For Germany he adds new information based on personal observation and on data published later than 1913. Writing during the stress of the World War, Dr. Frech had political and nationalistic aims in view, among them ultimate and permanent control of the Belgian fields by Germany. The book appears to exaggerate the potentialities of coal production in Germany while minimizing the reliability of British and American figures. On the whole, however, its value as a work of reference and as a corrective of "Coal Resources" is not vitiated by its nationalistic bias.

In regard to the British Empire the data supplied in "Coal Resources" may also be supplemented by J. H. Ronaldson's monograph, "Coal" (*Imperial Institute Monographs on Mineral Resources with Special Reference to the British Empire*, London, 1920). This contains detailed descriptions of the various coal fields of the empire in their geographical and geological positions. For the United States we know of no more recent general discussion than that contained in "The Coal Resources of the World." The history of the production of coal with full statistics is thoroughly covered in the serial publications of the U. S. Geological Survey. The latest number of this series is "Coal in 1919, 1920 and 1921," by F. G. Tryon and Sydney A. Hale (*Mineral Resources of the United States*, 1921, Part II, pp. 445–662, Washington, 1923).

Reference may also be made here to an admirable manual by Elwood S. Moore, "Coal: Its Properties, Analysis, Classification, Geology, Extraction, Uses and Distribution," New York, 1922. As the title implies, a large part of the volume is devoted to geological and technological matters of indirect geographical interest. On the other hand, as the utilization of various kinds of coal for different purposes and in different regions may be of much geographical significance, the student will find Professor Moore's chapter on classification useful for reference.

HISTORY OF GEOGRAPHY AND EXPLORATION

The Earliest Known Printed Map Showing America. The Contarini map, recently acquired by the British Museum and widely mentioned in the press, is of special interest because, so far as is known, it is the "very first printed map in which the discoveries in America are represented" (Mr. Edward Heawood discusses it in the *Geogr. Journ.*, Vol. 62, 1923, pp. 279–293). Previously this honor had been claimed for the famous Waldseemüller map discovered by Josef Fischer in 1901, and, prior to that, for the map of Johan Ruysch in the Rome Ptolemy of 1508. Important manuscript maps showing the American discoveries had been made, however, before 1506, notably that of Juan de la Cosa, who took part in the first expedition of Columbus, and the Canerio and Cantino maps.

The Contarini map is on a fan-shaped conical projection similar to that of the Ruysch map. As on other maps of the period, the northeast coast of Asia is made to extend eastward to a position not far west of northern Europe. The northern coast of South America is shown as a border to a great continent extending indefinitely toward the Antarctic regions. In the midst of a broad belt of ocean con-

necting the Atlantic and Pacific between South America and Asia lie Cuba, Hispaniola, and the other West Indies. No land is represented immediately west of the West Indies as on the maps of Juan de la Cosa, Cantino, Canerio, Waldseemüller, and Ruysch. Mr. Heawood points out that this omission tends to confirm the scepticism of those who doubt the authenticity of "Vespucci's discoveries in the extensive voyage which he claimed to have made on the coasts of North America in 1497–8." The belief that Columbus had reached the coast of Asia is indicated by a legend off the southeast coast of that continent.

Asia, as depicted on the Contarini map, is for the most part the Asia of the Ptolemaic atlases, the details of which came in part from Ptolemy and in part from Marco Polo, though it is probable that "*map*-sources not known to us must have been drawn upon too." Portuguese discoveries in the Indian Ocean are represented by the curious addition of a peninsular India to the west of the Ptolemaic India which is retained. Similar duplications resulting from the use of different sources of information in regard to one and the same region are not infrequent in other maps of the time. The general outline of Africa is good. The sources of the Nile are shown far to the south in the usual manner of the Ptolemaic atlases. The Blue Nile, the course of which had been drawn with accuracy in the map of Fra Mauro (1457–1459), is made by Contarini into a great *western* branch of Ptolemy's system of the Nile. In the outlines of Europe Contarini made many improvements over the maps of Ptolemy based on the examination of the more accurate marine charts of the day. To mention a single example, he eliminated the exaggerated eastward extension of Scotland.

The Geography of Dante. The writings of Dante Alighieri not only express the current geographical ideas of his age but also reveal much originality in the treatment of certain geographical problems. The poet's sources of information were primarily those great encyclopedic compilations that were so popular in the Middle Ages, though for local detail he drew upon his own memory of places visited and upon the reports of contemporaries. The influence of Arabic science had been a potent force in Western Europe since the eleventh century. Dante was largely indebted for his astronomy and astronomical geography to Al Farghānī (known in the Middle Ages as Alfraganus) whose "Elements of Astronomy"—itself based upon the "Almagest," or famous astronomical treatise of Ptolemy—was available in Latin translation.

Dante writes of geographical matters in the "Convito," in the "De vulgari eloquentia," and in numerous scattered passages throughout the "Divine Comedy." A general discussion of the poet's geography and its origins will be found in Edward Moore's "Studies in Dante: Third Series," Oxford, 1903, pp. 109–143 (abstracted and reviewed extensively by Giuseppe Boffito and E. Sanesi, "La geografia di Dante secondo Edoardo Moore," *Riv. Geogr. Italiana*, Vol. 12, 1905, pp. 92–101 and 204–215). Recently, Italian scholars have been investigating the poet's treatment of various important topics not touched upon by Moore. The results of these investigations are embodied in three publications: "La geografia nell'opera di Dante," by Assunto Mori (*Atti VIII Congr. Geogr. Italiano*, Vol. 1, Florence, 1822, pp. 271–299); "La carta dialettologica d'Italia secondo Dante, by Giuseppe Andriani (*ibid.*, Vol. 2, pp. 255–263); and "L'Italia nella Divina Commedia," by Paolo Revelli, Milan, 1923.

Dante believed that the earth is a sphere immovably fixed in the center of the universe and that it is 20,400 Italian miles in circumference. He held that the "emergent earth," or dry land, was restricted to an area not more than 180 degrees of longitude in length by about 67 degrees of latitude in width. The remainder of the sphere was covered with water. Of the three continents he probably thought

that Asia was equal in size to Europe and Africa put together and that the Mediterranean Sea was 90 degrees of longitude in length, or half the total length of the inhabitable world. Jerusalem he placed at the center of the lands and at the antipodes of Jerusalem the mountain of Purgatory with the Terrestrial Paradise upon its summit. He explained in some detail the correlation between differences in longitude and differences in local solar time and the division of the earth's surface into seven *climata* or zones the borders of which were determined by the length of the longest day.

With the exception of the theory placing the Terrestrial Paradise in the southern hemisphere—it was usually believed to be in Asia by medieval scholars—none of these views was altogether original. Dante's treatment of the larger problems of geography was for the most part in accord with the orthodox traditions of his age: though his assumption that the southern hemisphere is covered by water was based upon Arabic and classical, rather than upon patristic or subsequent European teachings. The theory, however, was a familiar one in the thirteenth century and was sometimes explained by the hypothesis that the spheres of earth and water, instead of being exactly concentric, have different centers. An interesting argument against this hypothesis is given in a treatise entitled "Quaestio de aqua et terra" often attributed to Dante but of doubtful authenticity. Here the presence of land in the northern hemisphere alone is ascribed to the power of the stars which "attract the land as a magnet attracts iron."

Though Dante wrote no treatise devoted specifically to geography, he had a clear understanding of the relative positions of places in Italy and its neighboring lands. The descriptions of regions in the "Divine Comedy" are brief but extremely incisive and accurate. In framing them it is possible that the poet may have had maps before him, and there are certain passages in the "De vulgari eloquentia" that could hardly have been written without reference to a map.

GEOGRAPHICAL NEWS

The Reports of the Eighth Italian Geographical Congress. The work of the Eighth Italian Geographical Congress, held at Florence, March 29 to April 6, 1921, is described in three large and handsome volumes ("Atti dell' VIII Congresso Geografico Italiano tenuto in Firenze dal 29 Marzo al 6 Aprile 1921," Istituto di Edizioni Artistiche, Fratelli Alinari, Florence, 1922–1923). On looking over the books one can hardly fail to be impressed by the ambitious scope of the geographical work being done in Italy and by its high scholarly standard.

The Italian geographical congresses have been held from time to time since 1892. The seventh met at Palermo in 1910. A long interval, therefore, preceded the eighth congress and explains in some measure the magnitude of the work undertaken by it. The eighth congress was divided into five sections designated severally "scientific," "historical," "educational" (*didattica*), "economic," and "colonial." Volume I of the "Atti" contains the texts of the three lectures delivered before the whole congress; together with the record of the proceedings, plans discussed, and votes taken. Volume II is devoted to the publication of the papers (*communicazioni*) delivered before the sections. Volume III includes a guidebook and chronicle of the excursions and catalogues of the exhibits.

Of the ninety-four papers read at the section meetings, thirty-six were devoted to scientific and twenty to historical geography; eleven to educational problems; six to economic and eighteen to colonial matters. To judge from the topics under discussion and the papers presented interest was overwhelmingly centered in the geography of Italy and her colonies. Except for communications on the thalassography of the Mediterranean, on the distribution of paleolithic industries in Europe,

on the Himalaya (based upon the expeditions of De Filippi in 1913–1914 and of Mario Piacenza in 1913), and a lecture by Father Alberto de Agostini on his journey to Tierra del Fuego in 1913, the attention of the congress was focused exclusively on matters of local and national concern.

Of the papers read before the scientific section, the majority were reports of detailed investigations in physical geography. To the subject of present and former glaciation in the Alps and Apennines were devoted no less than six communications accompanied by photographs and maps of peculiar glacial forms. An unusually interesting contribution by Professor A. Malladra on the crater of Vesuvius is discussed in the present number of the *Geographical Review* (p. 308). Among other contributions on local problems but of more than local importance may be mentioned Professor Carlo de Stefani's treatment of the geological and physiographic relations between the opposite sides of the Adriatic; in the field of thalassography a study of the currents of the western Mediterranean (see this number of the *Review*, p. 310) by Professors V. Baldasseroni and G. Stefanini; a study of the anthropogeography of Mt. Argentario on the Tuscan coast by Professor Assunto Mori; and, in phytogeography, a discussion of colonies of Mediterranean plants near Lago di Gardo by Professor A. Beguinot.

The long and rich historical background of their country and the intimate connection between geography and history in the curriculum have led Italian students assiduously to cultivate the fields of historical geography and the history of geography. One of the three lectures published in the "Atti" is a discussion by Assunto Mori of the geographical conceptions of the time of Dante (see this number of the *Review*, p. 319). Most of the contributions read before the historical section were on topics connected with the geographical and cartographic work of various Italian scholars and writers of classical, medieval, and early modern times.

Seven of the eleven papers read before the educational section were on the geographical work being done by Italian publishing houses. The economic section listened to communications on special agricultural and industrial problems in various parts of the Italian peninsula. The colonial section occupied itself primarily with the political and economic geography of the Italian colonies and of Anatolia.

Excursions were an important feature of the congress. The illustrated guide to the principal excursion through central Tuscany and the Maremma should admirably serve future students and travelers as a treatise on the physical, historical, and human geography of these regions.

The catalogues of the exhibits are of value from the bibliographical and cartobibliographical points of view. They include an extensive descriptive list of maps, geographical manuscripts, and printed books of the Reale Archivio di Stato of Florence, a catalogue of geographical maps of Italy dating from the fourteenth to the end of the eighteenth centuries, a list of the most important official maps of the present day, and a catalogue of geographical materials (books, models, maps, globes, etc.) exhibited by various Italian publishing concerns for use in schools.

The Geographical Institute of Petrograd. This Institute, established in the autumn of 1918, is the outcome of a long-continued effort to make advanced geographical study and research in Russia contribute to the preparation of teachers and government experts. It is an outgrowth of the Geographical Bureau, started in 1910, and of the Advanced Geographical Courses, organized in 1913 under the Ministry of Agriculture. Although space does not permit the mention of names, it may be noted that several members of these earlier undertakings are included in the personnel of the new organization.

The Institute stood, by 1922, as an independent member of the group of establishments for higher learning maintained by the Commissariat of Education.

There were then two faculties: General Geographical and Ethnographical. Besides the regular four-year course for specialists, the Institute maintained a preparatory course and a programme of public courses for the popularization of geographical knowledge. Despite material difficulties, classrooms and laboratory facilities had been obtained, field excursions organized, and a library of some 20,000 volumes assembled. The student body had risen to over 800. Student activities, through a general Geographical Club and special societies, formed an important supplement to the regular work.

The aim of the Institute is to provide, through its own curriculum and faculty, a complete education in geography and allied branches of knowledge. Owing, doubtless, to former connections, the early programmes displayed a strong bent toward the exact sciences and agriculture, at the expense of social studies; but, since the transfer to the department of education, there has been an increasing recognition of the relation of geography to politics, economics, and history. This tendency is particularly evident in the public lectures and incidental activities of the Institute.

As part of its educational work, and as contributions to the advancement of geographical knowledge, the Institute conducts expeditions transcending the character of routine field work. In 1920 such expeditions were carried out to the Kola Peninsula and to the Tver government and, in 1921, to the Caspian.

The Institute has had in view a policy of publication of the results of its expeditions and other work, of special studies, of textbooks, and of popular pamphlets. It has undertaken the preparation of a comprehensive atlas of the Petrograd government on a scale of 1: 600,000 and has been charged by the commission of the Supreme Economic Council with the study of the natural resources of Russia and with the compilation of the local volume of a new set of regional studies.

The Institute's own work of publication has been hampered by printing difficulties. It has contrived to get out its annual *Izvestia*, containing special articles and statements as to its work. In 1921 it began publication of a magazine, first called the *Bulletin* and, in 1922, changed to *Geograficheski Viestnik*, made up of articles, reviews, and news notes. Three small volumes of reports on the soil and vegetation of the Kola Peninsula, results of the expedition of 1920, have come to the American Geographical Society (see the note on the Kola Peninsula in this number of the *Review*, p. 307); likewise, a 300-page work on evolution, by Professor L. S. Berg, as the first volume of a series of monographs. A little pamphlet on the practical problems and political significance of geography is a sample of the work of popularization.

J. V. Fuller

A Course of Lectures on Polar Exploration. Mr. R. E. Priestley is giving a course of lectures on "The History and Science of Polar Exploration" at Cambridge University. The detailed syllabus is in itself an interesting and useful outline. Some idea of the scope is afforded by the titles to lectures, which read as follows: I, A Modern Scientific Polar Expedition; Scott's Last Expedition (*Terra Nova*, 1910–1913); II, The Geography and Early History of the Polar Regions; III, The Elizabethan Period of Arctic Exploration. Arctic Work and Methods to the Close of the Eighteenth Century; IV, Parry and Franklin; V, The North-West Passage: Nineteenth Century Arctic Exploration; VI, The Quest of the North Pole. The Peary-Cook Controversy; VII, [The Scientific Polar Expedition]; VIII, Early Antarctic Exploration; IX, The Attainment of the South Pole; X, Shackleton; XI, The Psychology of Polar Exploration; XII, Polar Ice; XIII, Polar Life; XIV, Man and the Polar Regions; XV and XVI, Polar Economics.

Obituary

Mr. Philip Lee Phillips, Chief of the Division of Maps of the Library of Congress since 1897, died in Washington, D. C., on January 4, 1924. Mr. Phillips' work dealt mainly with the bibliography of cartography. His principal work is "A List of Geographical Atlases in the Library of Congress, With Bibliographical Notes" (4 vols., Library of Congress, Washington, D. C., 1909–1920). This work includes 5324 titles; it is especially useful in its analysis of the various editions of Ortelius, Mercator, Blaeu, and other atlases of the same period. In 1901 had appeared a similar "List of Maps of America in the Library of Congress." A constituent part of this work, "A List of Works Relating to Cartography," appeared separately in the same year. At the time of his death Mr. Phillips left in unpublished manuscript form a descriptive list of books and magazine articles relating to maps, map-makers, and views which, if printed, would make approximately five volumes of 1000 pages each. Mr. Phillips also compiled lists of maps on Alaska, Cuba, and the Philippines (the two last accompanying bibliographies of these islands) and annotated catalogues on European topographic map series and maps dealing with the World War. He also edited reprints of various rare American maps such as Filson's map of Kentucky, Herrman's map of Virginia and Maryland, Fitch's map of the Old Northwest, and Cutler's map of Ohio. Mr. Phillips' numerous works, although in some matters reflecting the antiquarian point of view (such as giving prominence to the size of maps to the exclusion of their scales when these do not appear on the maps themselves), are indispensable tools, especially to the student of the historical geography of North America.

GEOGRAPHICAL REVIEWS

The Mt. Everest Expedition of 1922

C. G. Bruce and Others. **The Assault on Mount Everest, 1922.** xi and 339 pp.; maps, ills., index. Longmans, Green & Co., New York; Edward Arnold & Co., London, 1923. $7.50. 10 x 7 inches.

Since the appearance of a note in the *Geographical Review* for October, 1923 (Vol. 13, pp. 620–623), outlining the work of the Mt. Everest expeditions of 1921 and 1922 the book under review has been published. Like its predecessor devoted to the explorations of 1921 ("Mount Everest: The Reconnaissance, 1921," Edward Arnold & Co., London, 1922) the present volume is made up of contributions by various members of the party. General Bruce, the commander, gives a broad narrative of events. The first attempt to reach the summit (29,141 feet), by which an altitude of 26,985 feet was gained, is described by Mr. G. H. Leigh-Mallory. The attempt with oxygen, during which the climbers got within half a mile of the top and to an altitude of 27,235 feet, is narrated by Captain George Finch. The story of the disastrous third attempt, ending in the overwhelming of the climbing party by an avalanche below the North Col and in the death of seven porters, is told by Mr. Mallory. Notes on acclimatization at high altitudes, on color in Tibet, and on Tibetan culture are contributed by Mr. T. H. Somervell; and a note on natural history (plant and animal life) by Dr. T. G. Longstaff.

All other considerations were subordinated to the main purpose of the expedition: the attainment if possible of the summit of Mt. Everest. Consequently, though the work done was of great significance from the mountaineering point of view, less was accomplished geographically than in 1921. But, though little in the way of precise scientific observation is reflected in the record of the expedition, the volume is of importance to the geographical reader for the picture it presents of the barren landscapes of southern Tibet and of the stupendous scenery of the world's highest mountain. The incidental notes on Tibetan life and customs are also illuminating if not extensive.

In addition, the volume is full of valuable observations on the reactions of body and mind to high altitudes. The ability of the body rapidly to become acclimatized to elevations of over 20,000 feet was demonstrated. Prior to the expedition the view was widely held that such acclimatization was impossible. Experience showed, however, that physical exertions which seemed almost unbearably difficult upon first arrival at great heights became relatively easy after the explorers had remained several days at the upper camps. Mr. Somervell, indeed, does not see a theoretical limit to acclimatization "at any elevation below the top of Mt. Everest." In other words, there is vastly less difference in atmospheric pressure and oxygen content between 23,000 and 29,000 feet than there is between any two points differing in elevation by 6000 feet below the level of 23,000 feet. The body once adjusted to conditions at 23,000 feet does not have to undergo any further radical adjustments in the ascent to 29,000 feet. Provided, therefore, that weather conditions be favorable and camps be established at sufficiently great altitudes, it seems probable that the summit may be reached by a future expedition even without the aid of oxygen transported for the purpose.

The benefits of the use of transported oxygen, however, were established without question. With the aid of oxygen the second party managed to climb from 25,500 to 26,500 feet at a rate of about 900 feet an hour: the first party, consisting of men fully

as experienced and fully as fit physically and under weather conditions more favorable, if anything, could do no better than 330 feet an hour at corresponding altitudes.

The psychological effects of fatigue, prolonged exposure to cold and wind, and above all of insufficient oxygen are fully as marked as the physical effects. At great altitudes all the forces of environment combine not only against the body but against the mind and will as well. Messrs. Mallory, Finch, and Somervell, well aware of the importance of observing these psychological effects, illustrate them by many personal details of a sort that would seem trivial if told in connection with an expedition made under ordinary conditions. In connection with an expedition made into such an exceptional environment, detailed incidents and personal impressions assume a high degree of interest and value. These are given in the present case with simplicity, informality, and straightforwardness.

Gaspé Peninsula

J. M. Clarke. **L'Île Percée: The Finial of the St. Lawrence, or Gaspé Flaneries, Being a Blend of Reveries and Realities; of History and Science; of Description and Narrative; as also a Signpost to the Traveler.** xii and 203 pp.; maps, ills., bibliogr. Yale University Press, New Haven, 1923. $3.00. 9 x 6 inches.

Dr. Clarke has elsewhere written at length about this interesting part of the province of Quebec. His scientific reports have described in detail the geology and paleontology of the eastern coast of the peninsula, and his "Heart of Gaspé" has given us many interesting notes about its history and geography. In the present volume he has woven into a completed picture a long series of interesting facts about the country and its people and has succeeded in putting into words the charm which impresses all its visitors. There is no pen which could better be entrusted with such a task.

Percé is situated at the eastern end of Gaspé. In "L'Île Percée" we are not hurried at once to this most striking and interesting point on the whole coast; we approach it gradually, first by a route along the south shore of the peninsula and then by way of the St. Lawrence River. Along the former route we stop here and there to pick up bits of local color, to hear some interesting anecdote about places and people, or to listen to some personal reminiscences or bits of local history. It is now the habitant or the fisherman, now the Indian, now a bit of geology such as the Devonian fishes of Scaumenac Bay or modern fishing stories of a different variety taken from the Restigouche and Cascapedia streams which are used to entertain us. We pass on down the Bay of Chaleur past Percé to Gaspé Basin, the place where Cartier landed in 1534 and erected his cross with the arms of France and the scene of other interesting historic events.

An alternative pathway to Percé is by way of the St. Lawrence. This is a more difficult route, for this time we can travel only a part of the distance by train or motor car; but one who follows this route will find it fully as interesting as the one more commonly used along the Bay of Chaleur; one regrets that in "L'Île Percée" we are hurried along this northern route with only a few pages devoted to this whole stretch of coast.

The last part of the book is devoted to Percé and its vicinity. We are given historical sketches and a description of modern scenes; we are told something of the geology of the region and of its geological history; we are taken to Bonaventure Island and introduced to the sea fowl that inhabit its cliffs.

To the traveler who visits Gaspé the book has an especial appeal; to those who have not had that good fortune it serves to give a series of impressions that could not be obtained from any general geographic descriptions.

F. J. Alcock

Exploration and Control of the Colorado River

Lewis R. Freeman. **The Colorado River: Yesterday, To-day and To-morrow.** xix and 451 pp.; maps, diagr., ills. Dodd, Mead & Co., New York, 1923. 9½ x 6½ inches.

The assonantal titles of the two main parts of this volume suggest the topics with which it deals: "Finding the River" and "Binding the River." Mr. Freeman is a skillful riverman—"river rat," as he calls himself—and talented writer of books of travel. Here he turns to history—the chronicle of the exploration of the canyons of the Colorado—and to a discussion of the thorny problems of the control and utilization of that river's unruly waters. He writes in a simple, straightforward, and often colloquial manner. His restraint in the use of adjectives depicting the colors of the canyons is admirable, and the weakness of others in this respect—illustrated by citations and neat comments—provides him and his readers with no little amusement. The volume is too important a work to lack—as it does—an index and it would also have been helped by more detailed maps.

Before the appearance of Mr. Freeman's book the best history of the exploration of the Colorado River was F. S. Dellenbaugh's "The Romance of the Colorado River" (G. P. Putnam's Sons, New York and London, 1906). Writing seventeen years later, Mr. Freeman has brought the story up to date by recording the notable events of the years between 1906 and 1922. The final episode in the long record of exploration and adventure, which goes back to the days of the *conquistadores* of the sixteenth century, is not treated. This episode was the U. S. Geological Survey's expedition of 1923, of which Mr. Freeman was himself a member, and whose work is narrated in the present number of the *Geographical Review* (pp. 177–196).

Mr. Freeman has made use of documentary material not known to Mr. Dellenbaugh in 1906 relating to earlier voyages. Hence, the volume sheds new light, among other matters, on General Ashley's trip down the Green River canyons in 1825 ("the first boat voyage down any of the canyons of the Colorado"), on the old controversy over the wholly unfounded claim that James White had passed through the Grand Canyon in 1867, two years before Powell's first expedition, and on the voyages of R. B. Stanton and F. M. Brown in 1889.

The problems of "binding the river" are problems of irrigation, hydro-electric development, and flood control. It is towards solution of these that the recent U. S. Geological Survey work in the canyons has been directed.

A Physical Geography of Argentina

Franz Kühn. **Fundamentos de fisiografía argentina.** ix and 217 pp.; maps, ills., bibliogr., indexes. *Biblioteca del Oficial, Edición Especial,* Vol. 49–50, September–October, 1922. P. Preusche, Buenos Aires. 10 x 7 inches.

If there were available a first-class map of Argentina one would find upon it most of the material in this book. In addition the book contains photographs, a useful if not complete bibliography, and a number of statistical tables and maps. Dr. Kühn is to be commended for the convenient arrangement of a mass of material distinctly valuable in the study of the geography of Argentina and hitherto scattered in hundreds of references in several languages. There is a brave introduction by Professor Hicken, of the Military College at Buenos Aires, and in it one will find a mixture of many kinds of knowledge and comment thereon, but little on the subject of physiography. In spite of the "modern" views expressed in Professor Hicken's introduction the mode of treatment of the material can only be called antiquated. If geography is straight description, then this may be justly called a physiography,

for there is practically no explanation except in geological terms. It is interesting to know that in 1914 Argentina had a population of 7,905,502, or 2.7 per square kilometer, that Patagonia has a population of 0.13 per square kilometer, and that one-fifth of the whole population lives in Buenos Aires; but these are facts and nothing more. To become science they must be put into some sort of relationship with other elements, and if possible causal ones. There is a map showing the regional divisions of Argentina, and a series of maps dealing with the climatic elements, that is temperature, rainfall, and the like. Data respecting the climatic elements are then employed to subdivide the country into climatic regions and subregions. It is here that science appears. The author's specialty is botany, and we have a substantial ending to the book in Chapter 7, which deals with the ecology or phytogeography of Argentina. Ten phytogeographic regions are recognized. Physiographic and climatic conditions are made to bear upon an explanation of the distribution of plant life. Accompanying the volume are certain special maps in sheets. The Viedma Glacier is shown in a colored contour map, scale 1:300,000. The waterways in the neighborhood of the town of Paraná are represented in detail, and likewise the swamps and drainage ways of the Lake Iberá region in the Mesopotamian country of the northeast.

Volcanism in Alaska

C. N. Fenner. **The Origin and Mode of Emplacement of the Great Tuff Deposit of the Valley of Ten Thousand Smokes.** 74 pp.; maps, diagrs., ills. *Natl. Geogr. Soc. Contributed Technical Papers, Katmai Ser. No. 1* (*Papers from the Geophysical Laboratory, Carnegie Instn. of Washington, No. 480*), 1923. 10 x 6½ inches.

E. T. Allen and E. G. Zies. **A Chemical Study of the Fumaroles of the Katmai Region.** pp. 75–155; maps, ills. *Natl. Geogr. Soc. Contributed Technical Papers, Katmai Ser. No. 2* (*Papers from the Geophysical Laboratory, Carnegie Instn. of Washington, No. 485*), 1923. 10 x 6½ inches.

The first publication in the special research memoirs initiated by the National Geographic Society is an exhaustive statement of some anomalous features of volcanism presented by Mt. Katmai, Alaska, in its recent activity (1912). The actual eruption was not witnessed by any competent observer but undoubtedly had violently explosive early phases and covered the surrounding regions far and wide with a thin mantle of ash. The Valley of Ten Thousand Smokes, which extends some ten miles northwest from the base of the volcano, is also filled with pumiceous sand and ash of such a character and so distributed as to leave no doubt that the filling of the valley is a result of volcanic processes quite different from those which produced the far-flung ash mantle of the region. Fenner made an extensive examination of the field and, after a thorough study of collected material, has brought the general light of volcanology to bear on the problem. He concludes that the ash fill of the valley, enormous in volume, originated as a *nuée ardente*, or flow of hot ash, charged with a great volume of expanding gases. Flows and avalanches of this kind and the phenomenon of hot gas blasts are now well known. They generally originate from the crater, but at Katmai the field relations render such an origin most unlikely. Fenner provides evidence to show that the hot mixture of ash and gas was extruded from fissures extending from the neighborhood of the base of Katmai along the direction of the Valley of Ten Thousand Smokes.

The second paper deals also in the main with the Valley of Ten Thousand Smokes where the fumaroles are extensively developed. The authors made innumerable delicate measurements of fumarolic temperatures and collected many gas samples and incrustations. Topographic relations, surface water flow, and geological features were all carefully studied, and the materials collected have been submitted to refined

analysis. The results are an important contribution to quantitative volcanology. They show that many of the fumaroles are of deep-seated origin, though some may have originated in the ash flow. Fumarolic activity in the region is waning at an appreciable rate, with declining temperature. Some interesting special methods were developed during the research. The study of volcanic emanations, complicated at the outset by the difficulties of collecting truly representative gas, shows itself less and less reducible to simple statement as work advances. The authors hence exhibit the greatest caution in the interpretation of their results.

These publications are attractive in appearance and well illustrated with half-tone reproductions worthy of a better paper than that used. Each contains a map of the Katmai region in which the accentuation of the contours rather detracts from the important subject of the map. The pagination of the two numbers is continuous, and No. 1 has no synoptic guide to its contents.

Life on the Norwegian Coasts

Camille Vallaux. **Sur les Côtes de Norvège.** 189 pp.; map, ills. Librairie Hachette, Paris, 1923. 7½ x 5 inches.

One of the authors of "La géographie de l'histoire" takes a journey to Norway and sees so much on the way that he needs must write this little book about it, looking back now and then into history for the explanations of things and looking about him also with keen eyes at the life of the coastal people of Norway. The breadth and power of his observation suggest similar traits in the travel writings of the late Lord Bryce. There is much valuable information for the ordinary traveler without the style or substance becoming guidebookish in any degree. At the start there is an especially vivid and informing description of the differences between the outer and the inner waterways along the Norwegian coast. Instead of calling these complicated channels and narrow inlets *fiords* he distinguishes between the outer channels (whether broad or narrow) that are open at both ends and those that penetrate the land. The former are called *sunds*, the latter *fiords*. They are as unlike in physical characteristics as in life conditions. Strong tidal currents, relative openness to the sea, lack of communication from village to village except by sea—these are the predominating features. By contrast the water of the fiords is quiet. Village may communicate with village readily. It is only when communication is desired from fiord to fiord that the sea highway must be resorted to. Communication from point to point on the Norwegian coast has always been a problem from the earliest days down to the present. The northernmost point to which the railway reaches is a little more than latitude 64° N. This corresponds with southern Baffin Land or Dawson in the Canadian Yukon. It is the end of the great trunk line that connects Trondhjem Fiord with Christiania, the capital. The only other railway from the capital to the west coast is the line to Bergen, in latitude 60° 20′ N. Roads and telegraph lines have a greater extension, and private telephone lines are now widely extended. Their advantages are described especially for the Romsdal Fiord just under latitude 63° N.

While fishing engages a large part of the population of the whole coastal region, it becomes the exclusive occupation of the outer settlements in the *sunds*, and this is especially true at Romsdal in Nordland and Finmark; and in the case of the Lofoten Islands there is a migratory fishing population which comes from southern localities, even from Sweden and Denmark. The cold upland is uninhabitable and useless for all but about two months of the year. During the height of the summer season cattle are driven to the *fjelds*, or rocky upland pastures, and butter-making and cheese-making are at their height. A small difference in elevation makes an immense difference in the degree of cold. On the south, in the Jostedal region, latitude 61° +, the permanent ice ends at 1200–1300 meters (with much local variation). The pastures of

the upland extend to about 800 meters, but they decline toward the north, and at Hammerfest they are at 60 meters. Above these levels arctic conditions prevail.

The author's explanation of the fiorded coast of Norway raises dissent. After describing the work of the present glaciers and the abundant and varied signs of their activity, he comments on the recency of glacial action and concludes that the scale of the features excludes glacial action as the chief agent in developing these great depressions 1000 to 1500 meters deep from the top of the *fjeld* to the bottom of the fiords. He believes that the principal lines of the relief are due to crustal disturbance. This is to say both too little and too much. No one will deny that the great outlines of the relief are due to crustal warping and breaking. But the evidence of ice as the predominating agent in molding the details of relief and even the fiords themselves is overwhelming. We mention only a few of the elements in the argument: the normal ground plan of the drainage ways of the coast, the extraordinary similarity of the topographic features to those in alpine regions where glaciers are known to have been the chief agents in producing the present relief, the carving of these features in a region where glaciers are known to have existed and their absence in places where glaciers have never acted.

A Historical Study in Baltic Trade

H. K. von Borries. **Die Handels- und Schiffahrtsbeziehungen zwischen Lübeck und Finnland. Ein Beitrag zur Geschichte der Ostseewirtschaft.** xix and 214 pp.; bibliogr. *Probleme der Weltwirtschaft 36.* Gustav Fischer, Jena, 1923. $1.20. 9½ x 6½ inches.

The favorable location of Lübeck as a trading center is shown in its changing aspects, beginning with the days of the Hanseatic League and following through the centuries to the present. The above work traces not only the development of the trade of Lübeck with Finland but also her entire trade relations in the Baltic Sea regions. It points to the prowess of Lübeck's traders during the stormiest as well as most fortunate days of the Hanseatic League through its fall, through the subsequent rise and fall of Swedish mercantilism, to the founding of the German Empire and the beginnings of the World War.

The rise of Stettin and Hamburg, with their respective advantageous hinterlands and consequent handicap to Lübeck, is brought out. Lübeck's leadership in the Baltic trade in spite of competition with Danzig, whose development has in many respects paralleled that of Lübeck's is discussed in some detail. Attention is given to Lübeck's weakening position as a European trade center because of the rivalry with other near-by centers such as those mentioned above and because of the shifting world trade routes.

Lübeck's first contact with Finnish merchants occurred at the two opposite ends of the Gulf of Finland, namely Åbo in the west and Viborg in the east. The castles, fortifications, and museum collections of these towns stand as mute evidence of the once commanding position they enjoyed. Although they do not possess the importance today which was theirs in a smaller commercial world, it is significant that they still play an important rôle in the Baltic.

Although Finland has had a rather variable political career, its fortunes cast alternately with eastern and western culture, its people have retained a unity that is rather unique. The internal structure of the country has never been really seriously disturbed, at least never for a protracted period. Consequently the study of its continuous trade with a port like Lübeck offers opportunity for weighing the influences of external factors, as opposed to internal factors, upon the trade of a country. Geographic factors, political changes, tariff adjustments, and wars are all given consideration in their varying influences upon the trade relations between Lübeck and Finland. The work is well arranged, indicating careful research, and deserves a warm welcome

as a contribution to much needed scientific and intensive studies of trade development in various parts of the world.

There is a statistical appendix covering the trade, both in quantity and value, between Lübeck and Finland. The data are complete up to 1913. Another portion of the appendix includes data relative to the number of ships which have been engaged in the trade between Lübeck and certain specified ports of Finland from the earliest times to the present. The tables indicate the arrivals and departures of ships by ports for successive years. For the period since steam power was introduced the data are classified as to character of motive power. An excellent bibliography accompanies the publication.

EUGENE VAN CLEEF

BALKAN CLIMATOLOGY

VIKTOR CONRAD. **Beiträge zu einer Klimatographie der Balkanländer.** *Sitzungsber. Akad. der Wiss. in Wien, Mathem.-Naturw. Klasse*, Vol. 130, 1921, pp. 425–467.

In 1916 Conrad published a report on the climatology of Serbia (*Sitzungsber. Akad. der Wiss. in Wien, Mathem.-Naturw. Klasse*, Vol. 125, p. 1377). The present study deals chiefly with Albania and Montenegro and is really the outgrowth of the meteorological organization established for military purposes during the late war. In addition to the data secured at the stations which functioned during war time, there were also available observations from other regular climatological stations. The war stations were actually in operation from June, 1917, to September, 1918, only; but their data served for purposes of comparison and of broad generalization and were deemed worth discussion in view of the great lack of more reliable information from the area and of the certainty that a long time must elapse before any regular meteorological service can be established there. Exact values of the climatic elements are not yet to be expected. Every effort has been made to eliminate errors; and, when possible, reductions to the same period were carried out. Considering the scarcity of observations and the difficulties of analyzing and of comparing the data, the author has really done a remarkably good piece of work.

Extraordinary contrasts of temperature between the warm waters of the sea and the cold mountains adjacent to the coast are found in winter in the vicinity of the Bocche di Cattaro where the isotherms are so closely crowded that they can be drawn only with great difficulty even on a large-scale map. It is from these cold inland plateaus that the well-known bora of the eastern shores of the Adriatic blows in winter. During the colder months the deep valleys and lowlands are filled with very cold and stagnant air, a marked climatic characteristic of this rugged Balkan topography. The Albanian summer is described as being "unbearable" for natives of central Europe. This fact is ascribed to the frequency of high temperatures at night and in the mornings and to a monotony of the heat.

Remarkable contrasts in rainfall are noted. Cetinje has an annual mean of nearly 140 inches. This large amount is due to the forced ascent of the onshore winds over the high mountain barrier. Back from the coast the amounts are very much smaller. Here, as in the case of the temperature, topography is a very critical control. Great variability in monthly and annual rainfalls is characteristic of the whole area. In summer Albania has severe droughts. The cold-season thunderstorms of the Albanian coast are interesting phenomena. They apparently result from the movement of colder air from the land underneath the warm and damp air which lies over the coast and the adjacent waters. Snowfall records are few, short, and unreliable. According to report, deep and enduring snow cover is of regular occurrence in the eastern wooded parts of Montenegro. In common with other "Mediterranean" climates, Albania has unusually cloudless summers. The mean for a number of stations is less than 2/10. During its dry and sunny summer months Albanian vegetation dries up, while

the cloud-burst type of rainfall in autumn and winter washes away the soil on the slopes. Abundant vegetation is found only where there is sufficient water and where there is protection against the wind.

Dr. Conrad's discussion, dealing with an area climatically but little known, fills a gap in the literature of European climatography. It has the characteristics of most studies of its kind in that it presents the available facts systematically, clearly, and in standard form. But it lacks vitality. It is not interesting. It gives no descriptions of weather types. It contains only a casual reference or two to human or economic responses.

R. DeC. Ward

An Administrator in New Guinea

C. A. W. Monckton. **Some Experiences of a New Guinea Resident Magistrate.** x and 337 pp.; map, ills., index. John Lane, London; John Lane Co., New York, 1921. 9 x 6 inches. (Also published under the title "Taming New Guinea," Dodd, Mead & Co., New York.)

C. A. W. Monckton. **Last Days in New Guinea.** x and 287 pp.; maps, ills., index. Dodd, Mead & Co., New York, 1922. 9 x 6 inches.

The state of aboriginal society in Melanesia depends upon the relations of three powerful sets of interest—those of the missions, of the commercial development, and of the administration. The last is the regulating force, and Mr. Monckton's books are a splendid account of its methods in New Guinea prior to 1907. The first book is a narrative of roving life from 1895 to 1897 and of official work from 1897 presumably to 1903. The second carries the narrative to the end of the author's official career in 1907. Forcibly written, evidently very much as he would speak, Mr. Monckton's narratives provide a great deal of information gathered from personal experience in the districts under his command. Topographical descriptions, distribution of tribes, customs, and languages, accounts of weather, and the treacheries of coral seas, with their sudden shoals and tide rips and "gubas" (rain squalls), are simply recorded with no sign of an effort to be technical. Unfortunately the author has paid little attention to chronology, and, although events are doubtless dealt with in the order of their happening, it is difficult to place an occurrence in its precise period. But whatever be the faults of narrative presentation, Mr. Monckton convinces one of his authority. The work is honest, and New Guinea should benefit from his experience and criticism.

We gather a strong impression from an analysis of the narrative that, during the time of Mr. Monckton's experience, part of the southeast peninsula of Papua was in that phase of active colonization by native races which must precede stable settlement by groups of tribes strong enough to maintain ownership of their territories. In the region between the northeast coast and the Didina and Hydrographer's Ranges, for example, branches of the Binandere people were pushing southeast along the plateau-like eastern apron of the ranges The apron behind the Musa River and Collingwood Bay was in possession of the Doriri people. In the ranges to the west were utterly foreign hillmen (refugees?) occupying strong-point villages on the hilltops. To the east of the apron is a belt of grassland (partly uninhabited) and of sago swamps. East of this, along the coastal strips, were the small tribes, or grouped remnants of tribes, pushed outwards and hemmed in on all sides by misfortune. Unfriendly to one another, raided by sea and land, they readily welcomed the administration after recovering from the first mistrust. The whole relation suggests a colonizing movement along the apron (connected perhaps with drought and food shortage) by strong folk, who pushed the refugees aside to the coasts and mountains. The Agaiambu (the famous but erroneously-called "web-footed" people) seem to have been an extreme product of refuge. Before recollection, their tradition accounts them as refugees in the

morass and lagoons which receive the flood waters of the Musa. Here they developed an amphibious way of life which had a profound effect on their anatomical structure. Swept by an epidemic about 1870, they were reduced to about 40 in number in 1902 and are now extinct.

Monckton provides information which will contribute to the tectonic study of the D'Entrecasteaux and Louisiade groups and of Woodlark and the Trobriand group. His description of the small island of Iwa strongly recalls Hobbs's account of Chogach in the lagoon of Ponape, Caroline Islands, in its relation to aboriginal society (W. H. Hobbs: Cruises Along By-ways of the Pacific, Boston, 1923, pp. 37–38).

The later volume deals with the administration of the Northern as well as the North-Eastern Division and contains graphic accounts of the expedition to Mt. Albert Edward (13,000 feet) in 1906; and of an important traverse from coast to coast, via the Waria River, in what was then German territory, across the main range (11,000 feet), and down to the Gulf of Papua via the Lakekamu River, in 1907.

Notes on the puzzling archeology of the northeast hint at a very early occupation of Papua by an extinct people. The population of British New Guinea has been estimated at about one million. Monckton thinks that this is a considerable understatement. His evidence shows that even the highest mountains are occupied by a numerous and interesting hill folk, some of them being seminomadic.

The Strategic Focus of the Pacific

N. Golovin and A. D. Bubnov. **The Problem of the Pacific in the Twentieth Century.** Translated by C. Nabokoff. 256 pp.; maps, bibliogr. Charles Scribner's Sons, New York, 1922. $3.50. 8½ x 5½ inches.

The Powers of the Pacific are the United States and Japan. The authors have been greatly impressed by Mendeleiev's analysis of the Russian Census of 1907 (a work unknown in English) and argue that Japan has a serious population problem. Ethnic and environmental influences restrict the possibilities for successful Japanese expansion to certain climatic regions.

The United States stands seriously in the way of necessary expansion, in Hawaii, California, and the Philippines. The problem of the Pacific is therefore the solution of this difficulty between the United States and Japan. The authors regard it as an insoluble problem.

The efforts of Japan to secure an adequate base of supplies, especially of coal and iron, on the Asiatic mainland are analyzed, one might say exposed, with great directness. It is shown that Japan has entrenched a position which she could maintain as long as Russia stays in abeyance as an Asiatic power. Moral considerations compel the United States to adhere to the policy of occupation in the Philippines. The situation being thus, the authors do not waste time in predicting war but plunge into the strategic analysis of a naval campaign in the likeliest theater—the seas between southern Japan, China, and the northern Philippines. The overwhelming superiority and security of Japanese bases and the inadequacy of those of the United States, even were foreign bases open for use, seem to be evident. Apart from insuperable difficulties of transport to the distant theater, the United States navy seems to be at a disadvantage when compared with the Japanese, on the scores of tactical organization and composition of the fleets, speed of battleships, their armament, and the fact that the United States lacks battle cruisers. The comparison is based on the present condition and that on completion of the building program allowed by the Washington Conference. The outlook for the United States, in a last resort of conflict, is dubious.

The argument is well knit and sounds like a weighed utterance of opinion from able authority. It sets the mind working in an uncomfortable way. As a piece of writing alone, the book is gripping. It is like a course in naval strategic geography delivered by a teacher who compels admiration.

The Geography of Eratosthenes

A. Thalamas. **Étude bibliographique de la géographie d'Ératosthène.** 190 pp. Marcel Rivière & Cie., Paris, 1921. 10 x 6½ inches.

A. Thalamas. **La géographie d'Ératosthène.** 256 pp.; diagrs. Marcel Rivière & Cie., Paris, 1921. 10 x 6½ inches.

Eratosthenes was the greatest geographer of antiquity if depth and diversity of scholarship, originality of creative thought and keenness of critical spirit are true criteria. Born probably in 273 B. C. at Cyrene, then one of the leading intellectual centers of the Hellenistic world, Eratosthenes dwelt for a time in Athens and was called about 235 B. C. to Alexandria, perhaps to aid in the reorganization and cataloguing of the great library of which he became chief librarian some ten years later. At his disposal was not only the literature of what was by far the largest collection of books ever assembled prior to modern times but also the fresh geographical information gathered by the official surveyors and by the diplomatic, military, and administrative agents of a highly centralized and well-organized state.

Unfortunately Eratosthenes' writings have not come down to us intact. We know of them only in a multitude of fragments scattered far and wide through the works of later writers. Some of these fragments—for example the famous passage in Cleomedes' *De motu corporum caelestium* which describes Eratosthenes' method of measuring an arc of meridian—seem to represent with fair accuracy the thought and words of the Alexandrian scientist. Others are sadly garbled even at best. Indeed, there are some passages ascribed by ancient authors to Eratosthenes which cannot possibly have come from his pen. There are also numerous cases of apparent plagiarism where the Eratosthenic style seems to indicate the true source but where no acknowledgment of this source is given. Eratosthenes' geography, therefore, presents many thorny problems, which students have been trying to solve ever since the Renaissance.

In the two books under review M. Thalamas has set himself the somewhat Herculean task of clearing away the academic dross that in the course of centuries has accumulated around the interpretation of the work of Eratosthenes and also the more congenial one of explaining as clearly and reasonably as possible what is actually known about the geographer of Alexandria and what may justifiably be accepted on inference. M. Thalamas certainly makes no claim toward having settled definitely all the controversial points, and many of these will never be settled. We feel, however, that he has succeeded in his primary purpose; that of presenting a balanced estimate of the great librarian's contribution to the history of science.

The "Étude bibliographique" is devoted to philological matters. After relating the "history of the constitution of the text of the geography of Eratosthenes" M. Thalamas proceeds to a detailed examination of the text itself. He comes to the conclusion that the fragments are derived from two separate treatises, one primarily mathematical and entitled in all probability "The Exact Measurement of the Earth" and the other a geographical description of the inhabited earth entitled "Geographical Memoirs."

In "La géographie d'Ératosthène" M. Thalamas discusses the circumstances of Eratosthenes' life and surroundings and the material contribution of each of his two treatises to the geographical science of antiquity as a whole.

The work of Eratosthenes appears to have been characterized by a touch of individual genius, a combination of creative originality with critical acumen. Creative originality is nowhere better revealed than in his crowning achievement, the measurement of the circumference of the earth, of which M. Thalamas gives a thorough analysis. Besides being the first to attempt the measurement of the globe's circumference, Eratosthenes was the first to try to determine quantitatively how far the globe diverges from the form of a perfect sphere as a result of irregularities of its surface:

mountains and sea-filled depressions. Though earlier astronomers had associated terrestrial with celestial zones, Eratosthenes was the first to give "a genuinely scientific form" to the conception of terrestrial zones "by determining exactly on the sphere the position of the fixed circles which mark the limit of each." Likewise he was the first to describe in detail the physical features characteristic of the various zones and the first to invent a wind rose correlated with the direction of the axis of the globe and not merely with local positions.

Eratosthenes' critical acumen is everywhere apparent but nowhere more strikingly than in his rejection of Homer as an authority on matters of geography. He was unwilling to accept assertions merely because they had the weight of tradition behind them, and he sharply attacked the devotees of Homer. In passing judgment on the relative value of different kinds of information gathered for the compilation of his geographical description of the earth and for the construction of the map which he undoubtedly made, Eratosthenes' method seems alive with the critical spirit of modern science.

The Problem of Human Races

R. B. Dixon. **The Racial History of Man.** xvi and 583 pp.; maps, ills., bibliogr., index. Charles Scribner's Sons, New York and London, 1923. $6.00. 9 x 6 inches.

The study of human races began its advance towards scientific value rather late, and its progress has been much hampered by inheritances from the older studies of philology and politics, features valuable in those studies, it may be, but not of a nature to be applied without great care and reserve in race study. Those inheritances were very obvious in the works of the late Dr. Keane, and there has been for some years a desire to try to make a frèsh start. Dixon has earned the praise of his fellow workers by his courage in setting together the results of his wide and careful reading in a new and individual way, even though his fellow workers may not be able to travel far with him and may regret that his book does not take account of some other work of a fresh character such as the London Medical Research Council Papers by Leonard Hill, the later papers of Giuffrida-Ruggeri and Biasutti and especially their books (V. Giuffrida-Ruggeri: Su l'origine dell' uomo, 1921; Renato Biasutti: Studi di antropogeografia generale, 1912), and, one might add, the overbold yet in parts suggestive essay of Griffith Taylor published in this *Review* in 1921 (*Geogr. Rev.* Vol. 11, pp. 54–119).

The problem of human races is admittedly a most difficult one, as most human stocks are fertile *inter se* and as also controlled breeding is obviously out of the question as a line of research. How may we think of the development of human diversities? The biological thinker will turn his attention to Darwin's "Variation of Plants and Animals under Domestication" and will see that with the growth of human influence the conditions under which the later phases of ontogeny (individual development) occur have been markedly altered. Now it seems reasonably demonstrated that, in these later phases of ontogeny, a good deal has to be credited to the influence of stimuli from the environment. If, then, these are permanently modified, as by the prolongation of the supply of soft food in infancy following the domestication of plants and animals, the course of development may be altered. In the first place, some character erstwhile important may diminish and even disappear. In the second place, the balance of development may be altered; and this may well give rise to new features in many ways, just as, in social anthropology, the conjunction of inheritances and their modifying influences on one another may not merely inhibit one another but may also lead to the emergence of quite new features (see W. H. R. Rivers: The History of Melanesian Society, 2 vols., Cambridge, 1914). Thinking on these lines we approach a dynamic conception of the slow mutability of human character, fairly

closely, if withal very complexly, related to environmental influences. The diversities of man thus seem to be brought under the general scheme of "Variation of Plants and Animals under Domestication," as Giuffrida-Ruggeri suggested, but they are on the other hand less subject to alteration than Boas has claimed from his studies on changes in bodily form of descendants of immigrants into the United States of America on grounds of elaborate statistics somewhat inadequately analyzed. That thought concerning human diversity is leading anthropologists towards a geographic outlook is an important consideration for geographers, who have long claimed that their duty is to study relations between men and their environments and who thus find the newer point of view in race study right at the center of their sphere of thought; it is obvious that the relations of environment to man's physique and to his individual development are of the very first geographic importance. Geographers who neglect them may go far astray in their studies.

Another biological thought which is almost as fundamental for race study as the above is that of the principles of inheritance. Here it has been shown of late years that we reach the best view available at present if we think of characters inherited usually from one or other parent; i. e. if we think of each human being as a mosaic of his ancestors. This is one of the first principles of Mendelism, and we should be warned therefore against emphasizing "pure stocks" among men. It is, indeed, probable that it will be found more scientific to study race characters rather than races, though those characters are often tied together in bundles. In a sense Dixon's book is a welcome experiment in this direction even if he emphasizes the bundle rather too much for the taste of some. Taylor's 1921 paper in this *Review* was another courageous attempt, weakened by its excessive sweep of generalization, and it had one feature which unfortunately Dixon's book rather lacks. The study of human diversity misses a great deal if it omits a survey of human skin; for it is through our skin that we come into relation with environment, and skin characters are a guide to hair characters and to metabolism and thus to many other aspects of race study as well.

If it be fair to say that the alterations of relations between men and environments have influenced human diversities, largely through modifications in ontogeny, then it becomes important to think archeologically as well as biologically. One of the aims of archeology is to trace out the evolution, in time, of man's relations with environment; and the evidences of changes in this respect in the Aurignacean and Tardenoisian stages of culture show that they probably exercised a considerable influence upon human structure, e. g. of the skull (see H. J. Fleure: The Races of England and Wales, London, 1923, and *idem:* Some Early Neanthropic Types in Europe and Their Modern Representatives, *Journ. Royal Anthropol. Inst.*, Vol. 50, 1920, pp. 12–40). Dixon has hardly taken sufficient account either of the biologist's thought or of archeological work in his synthesis, which will best meet the proper meed of appreciation if it be looked upon as an attempt to study statistical data and to generalize from them. This, however, need not prevent racialists from deriving a good deal of profit from Dixon's review of statistical data, much as one regrets the omission of Czekanowski's paper on Poland (*Bull. Soc. Anthropol.*, Paris, 1920) and of Giuffrida-Ruggeri's statistical paper on Asia (English transl., "The First Outline of a Systematic Anthropology of Asia," Univ. of Calcutta, 1921) from the bibliography. Dixon chooses three characters of admitted value—cephalic index (b/l), altitudinal index of the skull (h /b), and nasal index. Using these he works out a set of distinctive combinations. Dolichocephaly (D), Mesocephaly (M), Brachycephaly (B), Hypsicephaly (H), Orthocephaly (O), Chamaecephaly (C), Leptorhiny (L), Mesorhiny (M), Platyrhiny (P) are the classes he uses. He emphasizes the extremes and suggests sight combinations of them, to which he gives names, viz.: DHP Proto-negroid, DCP Proto-australoid, DHL Caspian, DCL Mediterranean, BHP Palae-alpine, BCP Mongoloid, HBL Alpine, BCL Ural. Whatever may be thought of the names, there is certainly some value in the discrimination of these groups, but the omission of the middle terms

inevitably suggests that they result from intermixture of the extremes, a view which is perhaps only of limited applicability. Moreover, the classes sketched above are based upon averages and need careful handling if error is to be avoided. For example, in a DCL population in the Mediterranean region there is likely to be a DHL element due to survivals of early Neanthropic types, and between them and the ordinary Mediterranean the gradations are fairly fine. It would seem valuable to picture a DHM group evolving towards DHL and DCL in different regions under differing influences, and it is this process of evolution that is rather obscured by Dixon's method of treatment. His names are taken to be morphological labels, not geographical ones in the first instance; and so when he speaks of "Mediterranean" in America we must not imagine that he has hare-brained views about migration. He would probably state that morphological similarities in all three points imply some measure of homology, and with that none need quarrel. Both Taylor from his point of view and the writer of this review from a rather different one have urged that we may have true homology even between characters of men in regions so remote from one another as America, Australia, and Europe. Whether geographical names are the best ones for what are morphological types is another matter, and here it is difficult to follow Dixon. One cannot but welcome, however, at least one of his new names—that of "Caspian," which is a useful substitute for the overworked name of Nordic or proto-Nordic. The latter name might be restricted with advantage to the fully evolved tall, longheaded, fairly high-headed, narrow-nosed blond of northwestern Europe, etc. Dixon is inclined to see in changes of regional type evidence of decline of one stock and spread of another; but he might make his view far more valuable did he but suggest that, for example, brachycephaly in Europe seems to behave as a sort of Mendelian dominant, so that it has spread remarkably there. This does not imply that the sociological considerations the author brings forward are not of importance as well. It is a very good feature that Dixon always keeps clear of the error involved in the idea of "One region, one type."

Summing up, one must say that neither in biology nor in archeology is the book fully satisfactory; it does not sufficiently give us a picture of human nature in process of becoming. But its survey continent by continent is well done, with a few unfortunate omissions, and provides stimulating reading and food for thought. There are here many valuable bricks which may later on be used by Dixon or other architects for a more weather-proof building.

H. J. Fleure

The Abridged Edition of Frazer's Golden Bough

J. G. Frazer. **The Golden Bough: A Study in Magic and Religion.** Abridged edit. xiv and 752 pp.; ill., index. The Macmillan Co., New York, 1922. 9 x 6 inches.

Sir J. G. Frazer's life work has been so remarkable as to be a romance. He set out more than thirty years ago to solve the problem of the succession to the priesthood of Diana at Aricia. His reading spread ever more widely, and the original two-volume work grew into 12 volumes, while numerous and important volumes appeared outside the main series. The work of the author has in fact produced a mine wherein expert quarrymen may find treasure on all sorts of subjects connected with the earlier phases of civilizations and their survivals. No corner of the world about which there are books seems to have escaped his attention, and his thought ranges over many subjects which have bewildered readers anxious to follow the main trail. The student will therefore be grateful for this abridgment which keeps the arguments and conclusions and often the phrases of the original but tries to help us to see the wood in spite of the infinite multitude of interesting trees. The abridgment omits many footnotes and the references, but it keeps the literary beauty of the original and, in effect, presents the reader with a clearer argument.

The King of the Wood obtained his priesthood of Diana at Aricia by killing his predecessor, and he in turn was subject to being challenged to mortal combat by any one who attempted to pluck the golden bough. The elucidation of this custom led Frazer into the study of king priests and so into forms of magic, doctrines of incarnation, ideas of taboo, the perils of the soul, the killing of the divine person and analogous sacrifices, the eating of the god, evil and the scapegoat, fire festivals, Balder and the mistletoe, and so on almost ad infinitum.

The student of geography may well read and reread Frazer if he be inclined to overemphasize influences of environment, for the multitudinous references bring out endless similarities that not even the most courageous of us could ascribe to migrations of culture. At the same time the environment plays its part everywhere and induces local modifications which tell their tale provided we are careful to sort them out from cases of what may be called evolutionary or historical differences.

H. J. Fleure

Climatic Belts and the Development of Civilization

Siegfried Passarge. **Landschaft und Kulturentwicklung in unseren Klimabreiten.** 165 pp.; maps, bibliogr., index. L. Friederichsen & Co., Hamburg, 1922. 10 x 7 inches.

Siegfried Passarge. **Die Landschaftsgürtel der Erde: Natur und Kultur.** 144 pp.; map, ills., index. (Jedermanns Bücherei.) Ferdinand Hirt, Breslau, 1923. 7½ x 5 inches.

Whatever one's personal convictions may be relative to environmental influences upon the development of civilization, a reading of these two books must surely prove a stimulant to one's thinking along these lines. The two publications might have appeared as a single volume with a re-orientation of content: since they dovetail, their subject matter may be readily reviewed as a unit.

Passarge divides the earth for convenience of treatment into five climatic belts as expressed by the distinguishing plant associations. The belts are the two "polar caps with cold summers and winters, the two middle belts with warm summers and cold winters, and the hot belt with warm winters and hot summers." These are then subdivided. It seems a mistake, certainly, to speak of climatic "belts" or zones about the earth, when topographic differences and the irregular distribution of land and water preclude a belted arrangement of either climate or vegetation. The author admits a certain weakness in his scheme but seems to feel it justified in view of the absence of any perfect classification. In the second-named volume he delineates the belts, but in the map accompanying the first book his belts are so broken up by the subdivisions as to show that belts in reality do not exist.

Upon a closer examination of the maps it is difficult to appreciate the classification in all instances—for example the inclusion of the Puget Sound district and the northern half of the Great Lakes region, beginning at the western end of Lake Superior and continuing to Massachusetts Bay and Long Island Sound, as "Subtropisch-gemässigte Waldländer;" or the southeastern portion of the United States (excepting the southern extremity of Florida), extending from Galveston to the western end of Lake Erie and thence eastward to Long Island Sound, as "Subtropische Regenwaldländer."

However, these matters do not seriously impair the conclusions which the author aims to impress upon the reader. His purpose is to show the extent to which natural and man-made factors have operated in the development of our social progress and the processes which are now destroying modern civilization. In his "Landschaft und Kulturentwicklung," he points out that all peoples experience an early period of

internal development, a later golden era sometimes accompanied by an assertion of physical power, and an eventual decline. The cause of the decline may be attributed to circumstances inherent in the character of the people or to the effect of their environment. Passarge insists that the latter influence is decisive and then seeks to demonstrate the truth of his contention. He traces in a somewhat systematic manner the status of various groups of peoples in different stages of civilization, stating first the conditions of their indigenous culture, then the successes or failures of foreign influences consisting either of a civilization imposed by a conquering people or introduced by the slower methods of peaceful immigration, and finally the destructive effects of the climax modern culture which he terms "Maschinenkultur." This cultural stage he finds represented in the "middle" belt of the earth and best exemplified by the Germanic peoples.

Machine culture, or the mechanical age, has a degenerating effect upon the nervous system and tends to cause complete breakdown of the whole moral fiber. The reviewer can support this argument to the extent of citing the prevalence of neurasthenia among the Finns of New England who have come from the farms of Finland and now are engaged in factory labor. On the other hand there is no indication that the moral standards of the people have been so influenced as to have broken down their cultural attainments. Passarge is decidedly pessimistic and somewhat of an extremist in his views.

The last part of "Die Landschaftsgürtel der Erde" is given over to a discussion of city landscapes, and here again the author attempts to demonstrate how the transition from medievalism to modernism has been dominated by mechanical influences and how these effects have tended to disrupt civilization. He cites attractive Nürnberg with its medieval setting in opposition to the peripheral ugly new city. The unhygienic character of the narrow winding streets, the poorly lighted houses with badly ventilated rooms, and general crowding are freely admitted; but seemingly the consequent picturesqueness of the old city, its charm, and its appeal to the artistic temperament are to be preferred to the more healthful modern city of straight wide streets, barrack-like apartment houses, or American skyscrapers with their ant-like colonies of people pushing each other breathlessly in the chase for the dollar. Great modern cities represent the triumphs of trade in all its manifold aspects where the world's knowledge and technique are brought into closest working harmony. They also constitute the centers where people's souls are hopelessly poisoned and their very vitality is seriously impaired.

An appendix of thirty-one photographs of type landscapes, both country and city, accompanies the second publication, and a bibliography is appended to the first book.

EUGENE VAN CLEEF

OUTLINES OF CLIMATOLOGY OF THE CONTINENTS

W. R. ECKARDT. **Grundzüge einer Physioklimatologie der Festlander.** 123 pp.; maps, diagr., bibliogr., index. Gebrüder Borntraeger, Berlin, 1922. $1.10. 10 x 6½ inches.

To Dr. W. R. Eckardt we already owe several excellent contributions to climatological literature. "Das Klimaproblem der geologischen Vergangenheit und historischen Gegenwart" (1909) presented an important subject of great complexity in brief and systematic form. His "Paläoklimatologie" (1910) in the well-known Sammlung Göschen, still further condensed the material included in the earlier volume. And his "Klima und Leben" (1912), also in the Sammlung Göschen, brought a simple and very useful statement of the relations of climate and life from the point of view of a climatologist.

Dr. Eckardt's new publication is original in title as well as in the method of treatment of the subject. It deals with the climatology of the continents but contains not

a single table and hardly any numerical data. Its aim is to show how climate fundamentally depends upon the changes in seasonal pressure conditions. Pressures control winds and precipitation. Temperatures in their turn both result from the pressure distribution and also to a large extent control the pressures. There is thus an interlocking of causes and effects, the effects often reacting on the causes; but the key to the situation may be found in the distribution of pressure. Rainfall is the most critical single element in climate, and appreciation of a country's climate really centers in an understanding of rainfall causes and characteristics. The title of the volume before us is "Grundzüge," not "Die Grundzüge." It does not attempt to be exhaustive, but it certainly does give a vivid description of the climates of the continents from a viewpoint which is to a large extent new.

We ourselves have found the climatic outlines clear, vivid, and interesting. They are clear because well written and brief. They are vivid because proper emphasis is laid upon the seasonally varying weather types which make up the different climates. They are interesting because they have life and because the human and economic relations are constantly kept in view. Dr. Eckardt's little book should be on the shelf of every one who is concerned with climatology and who really wishes to get at the underlying controls of the climates of the world. This volume cannot, it need hardly be said, replace Hann's monumental "Handbuch," but it will serve as an excellent supplement to that absolutely indispensable work.

Of the 118 pages of text, 44 are devoted to Europe and only 10½ to North America. This inequality of treatment is probably excusable in the case of a German meteorologist, but it is a bit disappointing to an American. The Mediterranean area is given 15 pages and is admirably done.

R. DeC. Ward

Geographical Distribution and Origin of Species

J. C. Willis. **Age and Area: A Study in Geographical Distribution and Origin of Species.** With chapters by Hugo De Vries, H. B. Guppy, Mrs. E. M. Reid, and James Small. x and 259 pp.; maps, diagrs., bibliogr., index. The University Press, Cambridge, 1922. 14s. 9 x 6 inches.

Geographers are not much concerned with organic evolution; but the relation of plants, animals, and man to their environmental controls is a leading geographic problem. Willis was a student of natural selection thirty years ago and after ten years of observation decided to conduct an independent investigation of the subject. His viewpoint is largely that of the student of evolution, although his subject is almost equally geographic and ecologic. As a result of his studies he came to the conclusion that "plants spread very slowly, but at an average rate determined by the various causes acting upon them, so that age forms a measure of dispersal when one is dealing with allied and similar forms." We should at once recall that age is no more a cause of evolution than is natural selection, for both are negative influences. Age means, primarily, opportunities for overcoming limiting factors or controls.

After referring to the idea of single and multiple origin of species, the author states that most plants arise in moderate-sized areas and later enlarge them. The most common methods of dispersal of individual plants are by means of the wind, water, or by birds and other animals. These he calls "regular" methods. Many species are carried by "irregular" methods, such as hurricanes and floating logs, which ultimately are so general in their operation that one can safely predict a large part of the invaders upon a new area. Plants, he declares, have, as a rule, traveled only slowly and for short distances by the regular methods and in the long run also by the unusual or accidental methods. Even the most cosmopolitan genera of plants have little or no special mechanisms for dispersal. In other words, this means that they have practically solved the problem of dispersal.

A number of students have held the idea that the introduction by man of species from large continental areas to islands and into foreign countries permits them to make great progress in establishing themselves in exotic regions and in overcoming the native species on account of their assumed superiority in the struggle for existence. The prevalence of the idea has been due, largely, to the neglect of the facts which show that it is mainly the man-made conditions about his settlements that destroy the native organisms and make place for the foreign associates and that it is largely this fact that accounts for their apparent success. Cultivated fields, pasturing, the destruction of forests, and similar influences make way for the foreign "weeds," and there is no competitive superiority on the part of the "weeds" over the native plants. Furthermore, foreign plants do not, as a rule, successfully invade native forests and wild conditions. Yet, on the other hand, there are a few striking cases where introduced plants have made wonderfully rapid extensions in foreign parts. The author has done a good service in calling attention to the needs of a critical study of this problem. Much additional evidence on this subject is given in a recent book by G. N. Thomson on "The Naturalisation of Animals and Plants in New Zealand" (Cambridge University Press, 1922).

Willis thus summarizes his views: "The area occupied at any given time, in any given country, by any group of allied species at least ten in number, depends chiefly, so long as conditions remain reasonably constant, upon the ages of the species of that group in that country but may be enormously modified by the presence of barriers such as seas, rivers, mountains, changes of climate from one region to the next, or other ecological boundaries, and the like, also by the action of man, and by other causes."

The author asserts that in prediction he finds abundant proof of his theory. In 90 cases he has predicted and later confirmed his idea that groups of species which on the average have the widest range are the oldest species. Thus he maintains that the flora of New Zealand, by means of a land connection, dispersed its plants to adjacent islands, the flora of the New Zealand mainland being the oldest. The New Zealand species which have the widest range are thus inferred to be the oldest in New Zealand and to have the widest range upon the adjacent islands.

To the student of endemism, either plant or animal, as related to floral or faunal problems, the ideas of Willis will prove valuable and stimulating. The ecological aspect of the whole subject, however, is not thoroughly comprehended. The appreciation of arid regions in relation to endemism seems to be underestimated. Furthermore, one does not need to belong to either the natural-selection or the mutation school to dissent from what seems to be an overstatement of the importance of age and area.

With the assistance of zoölogists the author extends his generalization to various kinds of animals. In the case of certain animals as well as of certain plants we have historical records and much other evidence showing that the rate of dispersal is not only very unequal but may be very rapid. Students of ecology, with modern methods of approach, distinguish pioneer organisms invading new areas from the laggards which survive only in the later stages of succession. The very recognition of this succession shows that the progress of dispersal and the extension or range take place at unequal rates. This particular subject and its methods of thought seem rather foreign to the author. The rate of physical changes in environment ranges all the way from gradual to rapid; and this is true in general of changes in vegetation and in animals. These facts make Willis' sweeping generalizations seem too strong. Calvert has recently examined the American dragonfly fauna from the standpoint of Willis but is unable to agree with him in his conclusions. American students have given considerable attention to the centers of origin and dispersal of the flora and fauna, to which no reference is made by Willis.

It would be interesting to get the long-range view of a paleontologist on this prod-

lem of age and area. He is accustomed to noting the origin, expansion, and decline of organisms through the ages. He knows that there is a continuous rotation of old and declining types and of new and advancing ones. How does our present age fit into the general scheme? And how can the criteria of relative age be best summarized and formulated? A definite formulation would do much to clear up the treatment of these ideas.

The problem of age and area is a subject about which it is easy to fall into the error of reasoning in a circle. One can hardly doubt that age must have considerable influence. I have been unable, however, to escape the feeling that the author's conclusions go too far and appear to prove too much. The problem is not as simple as it seems, because the same result, wide dispersal, is probably accomplished by more than one rate and method, and the convergent results of diverse controls are frequently a source of error. The relative influence of each factor must be tested on its own merits. No one, however, can read the volume without recognizing that the book is a valuable contribution to biogeography and one that will prove stimulating reading to students in this field.

Charles C. Adams

The Tides and Their Utilization

E. Fichot. **Les marées et leur utilisation industrielle.** vi and 254 pp.; diagrs., bibliogr. (Science et civilisation. Collection d'exposés synthétiques du savoir humain.) Gauthier-Villars & Cie., Paris, 1923. 7½ x 5½ inches.

Tides and tidal currents—the movements of the sea in response to the attractive forces of sun and moon—are oceanographic phenomena which have, very largely, been relegated to the mathematician. This is no doubt due to the success which has attended the labors of the mathematician in this field, but as a consequence this large province of oceanography has remained almost closed to all but the mathematician. Despite Krummel's emphasis that it was the needs of the geographer and not those of the mathematician that he had in mind, he nevertheless made use of no inconsiderable amount of mathematics in the discussion of tides and currents in his "Handbuch der Ozeanographie." It is freedom from formal mathematics that distinguishes the volume under review and makes it a noteworthy contribution in this field of oceanography. Himself a mathematician—M. Fichot is a chief hydrographic engineer in the French Hydrographic Service and is further known as the editor of the third volume of Poincaré's "Leçons de mécanique céleste," which is devoted to tidal theory—the author discusses the tides and related phenomena in non-mathematical language but at the same time retains the precision of speech of the mathematician.

The introductory chapter discusses the various aspects of tidal phenomena, follows with a brief historical review, and concludes with several paragraphs on relativity and the tides. The second chapter is devoted to a discussion of the tide-producing forces, and the three succeeding chapters deal respectively with the undulatory movements of the ocean, the formation and propagation of the tides, and the conquest of "blue coal."

The author emphasizes the importance of resonance in the making of the tide; hence he naturally pays considerable attention to the stationary-wave theory of the tides developed by the late R. A. Harris. After describing the oscillating systems into which Harris divided the oceans, he notes that one cannot fail to be struck by a certain arbitrariness in this. He finds, nevertheless, that, despite all criticism that can justly be brought to bear against these oscillating systems, the explanation which they afford of almost all the varied phenomena of the tides "confers upon them assuredly a high degree of probability." As distinguished from preceding theories, the stationary-wave theory "has, furthermore, the great advantage of furnishing a logical

explanation for the formation of the [tide] waves and one that conforms to the requirements of the dynamical theory of oscillations." He concludes with Poincaré that the definitive theory "will probably have to borrow from that of Harris a considerable part of its principal features."

Of interest is the author's suggestion as to a possible connection between Harris' theory and the Wegener hypothesis. "Every tide proclaims a conquering heavenly body beyond the clouds; can this heavenly body have left its impress in the relief of the seas that it animates?" If the continental frontiers of the oceanic basins are, or have been, mobile, M. Fichot thinks that, given a considerable break to begin with, the tides may have played a rôle in the further separation of the continents. The author's argument may be summarized somewhat as follows: The pressure of the tidal currents against the opposite sides of an oceanic basin would become nil only in the case that the period of oscillation of the basin were the same as that of the principal tide-producing forces. With drifting continental masses the tendency would therefore be toward the formation of oceans of such size as to constitute basins of resonance under the action of the tides.

The last chapter, under the heading of "the conquest of blue coal" discusses the general question of the utilization of tidal energy and the various systems proposed to overcome the disadvantages of the variability inherent in the rise and fall of the tide. The concluding portion of this chapter is devoted to a description of the plans outlined for the utilization of the energy of the tide in the estuary of the Aber Vrac'h, a stream flowing into the English Channel about 25 kilometers north of Brest.

The book is written in a clear and pleasing style; but, dealing with a difficult subject fundamentally, it cannot be said to make easy reading. It is in no sense a handbook for the tidal specialist, nor is it a manual for the student, being addressed to the intelligent layman. It should prove especially valuable to the geographer in acquainting him with the problems and progress in this field of oceanography. A six-page bibliography, which the author states to be incomplete and to be limited only to the publications used in the preparation of the volume, adds to its usefulness, since it lists a considerable number of the more important recent publications. The almost complete absence of illustrations—there are but five figures in all—detracts somewhat from the full value of the volume.

H. A. Marmer

The Problem of Polar Wandering

L. A. Cotton. **Some Fundamental Problems of Diastrophism and Their Geological Corollaries with Special Reference to Polar Wanderings.** Bibliogr. *Amer. Journ. of Sci.*, No. 206, Ser. 5, Vol. 6, 1923, pp. 453–503.

A number of eminent astronomers have dealt with the possible displacement of the earth's pole. Under the assumption that the earth is perfectly rigid they found that geological processes would cause only an insignificant displacement; but if the earth is sufficiently plastic the pole might be materially displaced. The author examines the various phenomena which cast light on the earth's interior and concludes that it is sufficiently plastic to yield to forces acting for a long time in the same direction but has a high elasticity for periodic forces of short period—a conclusion which agrees with the views of most geophysicists. But the further conclusion that it is reasonable to suppose that the pole has wandered over considerable distances will meet with objections. It is quite evident, without investigation, that if you could sufficiently alter the distribution of matter in the earth, you could change the inertia pole to any extent; but what would produce such an alteration? It is easy to calculate, from the formulae that the author gives, that if the continent of North America stood everywhere two miles below sea level, and that then the material under it to a depth of

60 miles expanded uniformly so as to raise the surface two miles above sea level, the pole would be displaced less than two minutes of arc. It seems difficult to find in geological history movements sufficient to move the pole many degrees. Mr. Cotton thinks that "if the theory of polar wanderings be merely accepted as a working hypothesis no harm can be done." I would go further and say that it would do much good *if* it led investigators to a *thorough* study of the distribution of climates in the various geologic ages; for our knowledge of this subject is woefully unsatisfactory. Many eminent paleontologists do not believe that a change in the position of the pole would account for the distribution.

At the end of the paper is given a long and useful list of scientific papers dealing with the physical characteristics of the earth.

HARRY FIELDING REID

Regional Petrology and the Drifting of Continents

H. S. WASHINGTON. **Comagmatic Regions and the Wegener Hypothesis.** *Journ. Washington Acad. of Sci.*, Vol. 13, 1923, pp. 339–347.

The Wegener hypothesis of continental disruption and drift is stimulating every branch of geological thought at the present time. Dr. Washington contributes here a preliminary criticism from an examination of the petrological bearing of the hypothesis. If the pieces in the "jig-saw puzzle" of Wegener's primitive parent continent can be made to fit together, the igneous rock mosaic should match on the opposite sides of the breaks. Comparison of the comagmatic regions (i. e. regions where the igneous rocks are broadly related) on opposite shores of the Atlantic, in latitudes corresponding to Wegener's piecing together of the European and African with the American land masses, shows only the vaguest correspondence in their igneous manifestations. A few examples may be quoted from Washington's paper. The rocks of Baffin Land show a general resemblance to those of the Canadian Shield and offer no example, as far as known, of the alkalic series occurring in Greenland; Greenland lacks the anorthosites found in Norway; the Labrador anorthosites have no counterpart in corresponding regions of Europe; the Triassic traps of the Middle Atlantic States and the rather uniform lime-soda granites of the Appalachians cannot be paralleled in Europe; the critical regions of the Brazilian elbow and the Gulf of Guinea show great dissimilarity in their igneous rocks. An apparent resemblance exists on the flanks of the South Atlantic but loses its appearance of probability on close examination. The hypothesis may be regarded as unsupported by the evidence of comagmatic regions.

As igneous rocks form the great bulk of the earth's crust, in spite of their relative paucity of outcrop on the earth's surface, Dr. Washington's application of test is a formidable obstacle for Wegener. The requirements of isostatic adjustment, by lateral transfer of material at a depth, have not been considered in the paper and seem to need examination. They may well have had some effect on the bulky outpouring of basic material *after* the period of Wegener's hypothetical break-up of the parent continent and may help to make the evidence of the plateau basalts of the North Atlantic and South America, as well as of the magnificent Stormberg series of South Africa, more decisive.

Insect Plagues of the Tropics

ÉMILE HEGH. **Les Termites.** 756 pp.; map, diagrs., ills., bibliogr. Imprimerie Industrielle & Financière (Société Anonyme), Brussels, 1922. 9½ x 6½ inches.

Three groups of insects have held the tropics against the commercial advance of the white race. The tsetse fly has prevented the use of cattle and horses and retarded the agricultural development of the country; the mosquito has made the

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Index to the Bulletin of the American Geographical Society, 1852–1915. By ARTHUR A. BROOKS. With an historical and bibliographical note and a table showing the arrangement and composition of the series. xi and 242 pp. $2.00.

The Geographical Review. Vols. 1–11, 1916 to date. Successor to the *Bulletin of the American Geographical Society.* Monthly, 1916–1920; quarterly since 1921. Monthly numbers, 50 cents; quarterly numbers, $1.25; unbound volumes, 1916–1920 (two a year), $2.50; from 1921 (one a year), $5.00.

The Face of the Earth as Seen from the Air: A Study in the Application of Airplane Photography to Geography. By WILLIS T. LEE. With 67 oblique and vertical airplane photographs and 15 maps. xii and 110 pp. *Special Publication No. 4.* 1922. $4.00.

Desert Trails of Atacama. By ISAIAH BOWMAN. With 97 photographs, 21 maps and diagrams, and 1 colored map. 362 pp. *Special Publications No. 5.* 1924. $5.00.

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Map of Hispanic America, 1:1,000,000 [15.78 miles to 1 inch], Provisional Edition, Sheet South E–19, LA PAZ, 1922. Sheet South D–19, PUNO-RIO BENI, 1924. Sheet North 9–12, BAJA CALIFORNIA-SUR, 1924. $2.00 each sheet.

Map of Hispanic America, 1: 6,000,000 [about 100 miles to 1 inch], compiled from nearly 250 sources and showing railways, drainage, international and administrative boundaries, and towns in graded sequence down to those with a population of 4000. Produced in black in three sheets—measurements of 2 (to border) are 34 x 28 inches, and of the third 32¼ x 30 inches. 1922. $5.00.

Map of Alaska, 1:1,250,000 [about 20 miles to 1 inch], compiled from over 200 maps and charts. Printed on two sheets in five colors. Shows drainage, relief (1000 feet contours), settlements and towns (1920 census population given where available), communications, national parks, forests, etc. Size of two sheets when joined 49½ x 62½ inches to outer border. 1923. Unmounted, $2.00 (postage 25 cents); library edition mounted on cloth, $5.00 (postage 50 cents).

Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.

④ THE
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CITIES OF THE PO BASIN
AN INTRODUCTORY STUDY

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The Basin of the Po is not in the full sense Mediterranean. Myres[1] in his vegetational map of prehistoric Europe rightly marks it as a region of broad-leaved deciduous forest rather than an evergreen or summer brown country, while he also, rightly, shows that the olive barely enters its south-eastern corner. One may travel about the Po Basin and only rarely meet the olive tree, which is the characteristic, or index plant, of Mediterranean life; it is only as one approaches Pesaro that its beautiful grey green is added to the landscape.

Diversity and Transitional Character

The simple fact is that the mountain lines that girdle the basin on north, west, and south give it an almost continental climate. Anticyclonic conditions develop in winter, and the lowland just to the south of the Po near Pavia may have a frozen January, while Emilia, facing north, also feels the cold severely. The general southward slope in Lombardy, on the other hand, has a milder climate. The great heights of the Alps catch some rain at nearly all seasons and give a perennial supply of river water from their glaciers and the great lakes, which in several cases have accumulated behind morainic dams. Emilia, on the contrary, gets less rain in winter and also less in summer and seems to depend largely on what falls during the changes of seasons. The Piedmont plain to the west with more than a semicircle of mountains opens eastward and is higher than the Lombard plain. The rainfall is on the whole less; and the aspect of most of the Piedmontese slopes promotes greater contrasts of temperature, although warm southward downslopes, like that round about

[1] J. L. Myres: Ancient History, Cambridge, 1922, Vol. 1, Map 3.

FIG. 1—Sketch map showing the chief cities of the north Italian plain. Scale 1 : 3,300,000.

Asti, have long been famed for their vineyards. The Lombard plain also contrasts with Venetia, which has drier conditions, less constant rivers, and more winter cold. So it comes to pass that Piedmont, Lombardy, Venetia, and Emilia are to a considerable degree distinct natural regions in a physical sense.[2]

The Po has not been easy either to navigate or to cross. From prehistoric times there has doubtless been a good deal of swamp along the axial river, however much of this swamp may have become controlled by irrigation schemes. It has been a divider rather than a unifier. The region of the Po Basin has not at any time, for long, been a human unit nor the

TEMPERATURE OF THE NORTH ITALIAN PLAIN

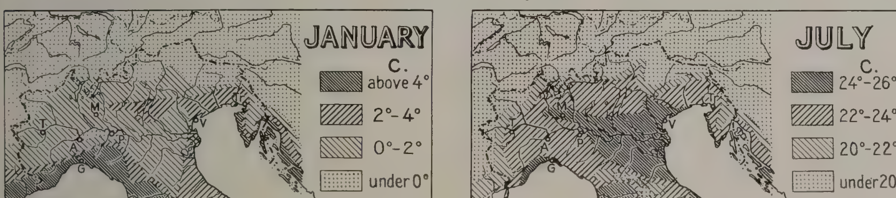

FIG. 2—Isotherms for January and July in the north Italian plain. The climate of the Po Basin is comparatively extreme: note for instance the greater range on the western shores of the Adriatic as compared with the eastern shores.

basis of any durable organization. To realize this and the great mountain walls, line behind line, between the basin and peninsular Italy is to appreciate physical reasons which, added to traditional ones, help to explain the tardiness of development of linguistic nationalism in Italy, as compared with what happened in the Paris Basin, or on the English plain. It is as true humanly as it is physically that the Po Basin is not fully Mediterranean.

In Neolithic times the lake villages of Switzerland must have been an important feature of the life of the continent. Their civilization found its easiest expansion downstream to the north. On the south side of the Alps the mountain barrier was high, the slopes difficult and perhaps very thickly wooded, transition to the plain sudden. Nevertheless this type of life passed the barriers and apparently just before bronze came into use spread lake villages among the Italian lakes and the stream beds leading to the Po. In other words Lombardy acquired elements of population and civilization from the north at least as early as the last phase of the Stone Age, and she has received them at frequent intervals ever since. The motives encouraging movement into Lombardy are obvious enough and much more marked than incentives to occupy Piedmont or Emilia or even Venetia, but the lake villagers reached all these. The population

[2] The physical and human variations in the plain of the Po are the subject of an interesting paper by Arrigo Lorenzi: Studi sui tipi antropogeografici della Pianura Padana, *Riv. Geogr. Italiana*, Vol. 21, 1914, summarized by M. E. Bénévent in *Recueil des Trav. de l'Inst. de Géogr. Alpine*, Grenoble, Vol. 4, 1916. It deals essentially with rural conditions.

of the Po Basin to this day is largely Alpine (brown-haired and broad-headed) especially in Lombardy, although everywhere one also finds the smaller dark long heads of Mediterranean type. In Venetia the Alpine broad head seems to have influenced a tall dark type of, as yet, very uncertain relationships. Researches into race history show that about the time the use of metal was arising in western Europe invaders, the so-called "Beaker people,"[3] probably not as yet armed with metal weapons, spread far and wide. There seems little doubt that they penetrated, or helped to lead a penetration, into Lombardy through the mountains, probably using the Brenner route. Thus, full early, we find in the Po Basin the meeting of Mediterranean and Central European peoples and cultures, and we have but to remember that for the Romans the region was Gallia Cisalpina to realize that they thought it foreign to their homeland.

Roman Influence on City Development

Though it might in a sense be foreign, it was yet so important as the starting point of their diverse routes into western and central Europe that the Romans worked here to make the region still more deeply their own in culture than Gaul beyond the Alps. It was more deeply Latinized than any other conquered region farther north or west; and Verona, Milan, Bologna, and many other cities retain strong Roman traditions, while Ravenna, in the marshes near the friendly Adriatic with its Byzantine connections, became the refuge of Honorius when he withdrew from Rome.

The invasions following the decay of the Roman Empire brought among other peoples the Lombards. Who they were is a matter of dispute though many would hold that they were probably a compound of Nordic, Beaker, and Alpine peoples forcing a way, like so many predecessors, through the Alps. There do not seem to be many pure Nordic types in the Po Basin; but a certain amount of fair hair is a noteworthy feature, and red hair occurs now and then. The well-known difficulty of Nordic infancy and youth in a really warm-summer climate would probably suffice to account for the present rarity of the type in northern Italy, even if it ever arrived in any numbers. The point of present interest is that apparently the northern invaders, hunting and country-loving folk, did not make so lasting an impression in the Po Basin as in the Paris Basin. The period of the weakening or submergence of city life was shorter; its renaissance, promoted by the vigor of the already half-Latinized invaders, quicker and earlier. Whereas in the Paris Basin the town of Roman times seems to have gone through a period of practical ruin, and in the south of France the regrowth of city life is distinct enough in time and expression from the decline, in northern Italy the distinction, though still marked, implies a shorter break in time and thought.

[3] See H. J. Fleure: The Racial History of the British People, *Geogr. Rev.*, Vol. 5, 1918, pp. 216–231.

FIG. 3

FIG. 4

FIG. 3—The Pineta, "Ravenna's immemorial wood," on the marshy plain between the city and the sea. (By courtesy of the Touring Club Italiano.)

FIG. 4—S. Apollinare in Classe, one of the most famous of the churches of Ravenna, the sole remaining building of her port of Classis.

Another factor, already hinted at, is important here; and that is the Byzantine connections via the Adriatic. Constantinople among its many heritages, Adriatic as well as Aegean, included the modified continuance of the age-old maritime intercourse of the Mediterranean, and the Eastern Empire kept control of numerous coastal patches around the great sea during the Dark Ages. Ravenna with its varying relations to Constantinople preserves for us memorials of city life in those troubled times; and we have traces at Torcello as well, in the northern part of the Venetian lagoons.

Ravenna, a City Apart

It is common knowledge that Ravenna was a port with its naval harbor at Classis near by. Both are now far from the sea among the fields, with the Pineta protecting the land from the shore sands; and the old marshes that made Ravenna impregnable are much reduced. There has long been no *raison d'être* here for a large city: thus it comes about that Ravenna retains almost unchanged its mausolea of the fourth and succeeding centuries, and its churches are only a little younger; both mausolea and churches are famous for their rich mosaics. The churches have indications of very early tradition in their form and detail and constitute a precious document for the interpretation of pre-medieval thought. Ravenna survives as a little country town and minor railway junction, with ten to twelve thousand inhabitants and little enough to do beyond the cherishing of ancient memories. It is a city apart and yet valuable for those who seek to understand the roots whence Venice grew. Torcello with its two churches and three houses or so, the latter built of monastic remains, is akin to Ravenna architecturally and again invaluable to show upon what basis grew the early renewal of art and architecture as the Middle Ages began in northern Italy. We may permit ourselves this short glance at Torcello, probably the first historic settlement in the Venetian lagoon, without incurring any responsibility for a treatment of Venice. The Queen of the Adriatic has so many features of her own and is so often discussed that it may well be omitted, and one might debate endlessly the question whether it should even be thought of as a city of the Po Basin.

Fall-Line Towns: Verona

The frequently sudden junction between mountain and plain in northern Italy is marked, as are similar lines almost everywhere else, by a line of towns, which here are connected with country market activities and the exchange of products between upland and lowland. Some, giving access to through ways across Alps or Apennines, are larger than others; and the character of the town varies to some extent from region to region. Among them one may note Turin, Vercelli, Novara, Magenta, Monza, Bergamo (Città alta and Città bassa), Brescia, Solferino, Verona, Bassano. Farther out in the plain, at least farther away from the mountains, is the great

focus of Milan, of perennial importance. Verona, and Turin is in similar case, in a sense combines the character of a focus with that of a town at the fall line. Here the Dolomites stand out far to the south of the general line of the Alps, and the low country between the exit of the Adige from its great valley in those mountains and the axial swamps of the basin is not very broad. Moreover, the Adige valley from Verona up, as one of the ways to the Brenner, gives Verona an added significance. From Lombard or perhaps rather from medieval times Alemannic colonies have settled in the Adige valley, and Alemannic dialects linger still near Verona.

FIG. 5—Verona. The fourteenth-century bridge of the Scaligers connecting the city with the Castelvecchio. (By courtesy of the Touring Club Italiano.)

To appreciate that queenly old city, however, one must bear in mind another consequence of its position at the exit of the Adige on to the narrow zone of plain north of the axial line of the Po. That narrow zone is the link between the great semicircle of Lombardy on the west and the Venetian plain on the east; so that Verona stands between two great regions, and its Ghibelline, Venetian, and Austrian fortifications remind us of the strategic factors that have conspired both to give it importance and to constrict its growth. When its foremost line of rulers, the Scaligers, were weakening (at the opening of the fifteenth century), it was disputed between Milan and Padua. In Napoleonic times France and Austria actually divided Verona between them for a short period.

With all these geographical factors behind it, Verona has become in a broad sense an epitome of the region. It stands in a strong position against a crossing of the Adige, and its pre-Roman existence is fairly established. Of its Roman life the fine amphitheater is the best memorial among many, and as one stands on the top wall of that immense monument one may look up to the white Dolomites reddening in the sunset or down to the plain. Beneath one's eyes lie the old town with its churches that typify the very beginning of medieval work and suggest the Byzantine as well as

Roman influences antedating that beginning, the castle that guards the bridge studded with the stone tooth work of the Ghibellines, the medieval gardens and churches, the old market place, the tombs of the Scaligers, the famous avenue of tall dark cypresses on the hillside, the little paved ways of the constricted shopping area, and, outside the gates and walls, the

FIG. 6

FIG. 7

FIG. 6—Portal of the Church of S. Zeno, Verona. The large, little-recessed, round-arched doorway is Romanesque in character. Cf. Figure 7. (Photograph by Evan Jones, University College, Aberystwyth.)

FIG. 7—Portal of the Church of S. Michele, Pavia. Recessed round-arched doorway showing northwestern influence. Cf. Figure 6. (Photograph by Evan Jones, University College, Aberystwyth.)

fortress of the Austrian rulers of last century with the new station that typifies the new Italian unity just beyond. Verona and Ravenna are the greatest of contrasts. Ravenna tells of one period in which little was being built elsewhere, and a few trains and an occasional steamer up the canal are almost all that prevent us from thinking of the little town as having slept on from the Dark Ages. Verona is full of energy, busy shops, busier markets, monuments of all periods side by side incorporated into the life of the present, bookshops filled with thought for the future to work out, efforts to maintain and redevelop the handicrafts—all is life and continuity.

An example of the continuity of tradition is to be found in Verona's greatest Christian monument, the church of San Zeno. Here we see the

earlier church as a crypt and, so far, like the crypts of many a church of Transalpine Gaul and Britain. In the Po Basin, however, that earlier church was less rude and had monuments too fine and too sacred to be hidden away, hence the crypt was left open to view from the nave of the newer, but still early, Romanesque Church. This feature, which is found

FIG. 8—The tombs of the Scaligers: the best example of Gothic architecture in Verona. (By courtesy of the Italian State Tourist Department.)

in many another early medieval church in northern Italy, distinguishes these churches from the corresponding ones in the Paris Basin and Britain. The doorway of San Zeno again brings out the continuity of tradition in Italy. In the Paris Basin and Britain the early medieval builders used the idea of the round arch but often were not able to make more than a small one. To increase the size and effect of their arched doorways they added arch over arch, each projecting a little in front of the one beneath, so that the actual doorway was deeply recessed. The beauty of these doorways at Avallon, Caen, and Canterbury—to name only a few—is generally known. At Verona the round-arched doorway is large and less recessed; the skill and resources of the builders were here sufficient to the task; and the doorway is thus characteristically different from the type found in northwestern Europe. Recessed round-arched doorways of northwestern

type, however, are found at several places in the Po Basin, again illustrating the transitional situation of the north Italian plain.

The difficulties of the Romanesque architecture for the builders of the northwest led them to modify it into the Gothic style, which generally uses the pointed arch. The Paris Basin is the home of this style, whence it spread to Britain, the Low Countries, and Central Europe. In southern France and in Italy it met only with very partial success. At Verona the Gothic style is best seen in the tombs of the Scaligers, which are protected by the finest flexible lacework in wrought iron. The Gothic style is nevertheless most obviously not at home in Verona, and one might say much the same of northern Italy generally, in spite of San Petronio at Bologna and the Cathedral at Milan.

Milan, a Focus of Ways

If Verona, in the tombs of the Scaligers and the German dialects of its district (the Sette Communi)[4] shows northern ideas, Milan shows them not only in its strange cathedral but also in many details of its streets, its monuments, and its life. A focus of ways through the Alps (including the St. Gotthard and Simplon routes), its military importance has been of the greatest and was undoubtedly restrictive of other developments in centuries past. In the Middle Ages it concerned itself with wool; but from 1850, when the idea of silkworm rearing and mulberry leaf culture spread on a large scale in Italy, Milan was able to supersede wool by silk and, like many another primary industrial center, has advanced to the secondary stage of supplying machinery, credit, and organization. The utilization of hydro-electric power at a distance from its source in the last decade of last century gave the Po Basin, and especially Milan, a great opportunity, for it solved old difficulties due to lack of coal or oil. Hydro-electric power was spreading also in Switzerland, South Germany, and Austria; and many new commercial links were developed between Milan and the cities on the northern side of the Alps, accentuating and renewing connections centuries old through movements of technicians, directors, and capital between the various centers. For these reasons, as well as because it was assuming the character of a financial metropolis, Milan has been becoming more cosmopolitan; and the contrast between it and Verona is about as striking as that already mentioned between Verona and Ravenna. With abundance of clean power and a long tradition of dexterous workmanship and of taste, Milan and cities similarly placed may have a great future industrially, with less degradation than seems to be characteristic where coal industry creates huge agglomerations of people in places previously of little account. These tendencies are further helped by the occurrence of rich cultivation around the city.

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[4] Leon Dominian: The Frontiers of Language and Nationality in Europe, New York, 1917, pp. 68–69.

Cities of Lombardy and Piedmont Compared: Turin

The cities of the fall line in Lombardy often have rich treasures of art in many fields and sometimes exploit hill sites of delightful character, though old-time fortifications have often made their centers crowded and poor, if picturesque. Soave, on its hill, may be mentioned as a most interesting little one, gathering around a castle. There are also beautiful sites on the great lakes and on their fine islands. Villages are on the whole

FIG. 9—Turin, occupying a strategically and commercially important situation at the western end of the north Italian plain. (By courtesy of the Touring Club Italiano.)

more characteristic of the hills, where some picturesque old hamlets stand on little pasture ledges, *alps*, high up the hill slopes and where torrents turn old mill wheels. In the plain the large farm establishment is more characteristic, and its extensive buildings bespeak a good deal of organization. The roof of the dwelling house is often continued beyond a reëntrant angle on the south or southwest side of the house, and its edge is then supported on pillars so that much of the life of the household can go on out of doors under its protecting shade.

In Piedmont there is rather more of a feeling of northwestern Europe. Turin is a Roman city, and the Roman roads have helped to determine the modern streets; but, as usual, the present streets may not be exactly on the Roman lines, for these have been covered up, and little deflections may have accumulated. Turin became the usual seat of the dukes of Savoy comparatively late, in the second half of the sixteenth century, and rather lacks medieval splendor. Many a little town or large village of Piedmont gathers around its castle and is often provided with walls and gates, which, as at Arquata Scrivia for example, have led to congestion within, though

the narrowness of the alleys is doubtless also a protection against the sun. The concentration of the people into groups, large and small, is characteristic here again, though there are also farms scattered over the country. Many of the old towns have interesting early Romanesque churches, but there is not the magnificence of Lombardy and Verona. The mulberry is largely lacking, and silk has not superseded wool; but hydro-electric power has led to machinery development, and Turin, for example, has great fame in engineering.

Padua and the Universities

From the Adige and Verona eastward one moves into another land, the coastal plain; and here perhaps the Byzantine connections, perhaps the influence of Venice and its famed campanile, perhaps the flatness of the plain, probably all these three factors together, have led to the building of churches with tall slender spires and campaniles, whose proportions are often very different from those of Lombardy. On the northern side of the axis of the Po Basin the great town of the coastal plain is the learned Padua with its ancient and magnificent town hall on the market place; with its memories of Dante and of Giotto, whose frescoes in the church of Santa Maria della Arena are its pride; and with its university, probably next in age to that of Bologna and the historic rival of that mother of learning. The city stands, as it were, over against Venice, and land travel from the old commercial metropolis would use Padua whether it were aiming at Verona and Lombardy, or Verona and the lower Adige, or the Val Sugana and the upper Adige, or the col d'Ampezzo and the Pusterthal on the way to the Brenner, or the coastal plains to north or south. It is thus a gathering place for Venice, as Bologna is a gathering place for travel southward to Tuscany and Rome, and Pavia on the Ticino a gathering place for crossing the Po which, below that town, becomes a barrier with swamps, and now dikes, on either hand. There are several other universities in the Po Basin below Piedmont, where Turin carries the renown of learning; but these are the three of sustained and world-wide fame, and their sites illustrate what has been so characteristic in the growth of historic universities, namely their development at purposeful gathering places, places where men of diverse origins and outlooks gather to travel along a common way. At Bologna the nations, as represented by their pilgrims and wandering students, met to improve their Latin on their way to Rome and learned the law that Rome handed down; and the faculty of law was long supreme at the senior university. Padua and Pavia we have noted in passing, and we might illustrate the same points from Paris, Leipzig, Louvain, or Prague, or even from Oxford or from Cambridge. It is probable that with the huge development of communications this factor no longer operates in quite the same way; but there can be little doubt that the mingling of groups of diverse origins and minds is still an essential for a healthy university. Of the lesser universities of the Po Basin,

one may just mention Ferrara, on the south side of the Po crossing, because it illustrates the same point though in a minor degree.

Towns of the Via Aemilia

The contrast between the northern and southern sides of the Po is a very marked one, as has already been suggested. The wealth of cultivation is

FIG. 10—Pavia, a "bridge town" of the Ticino near its confluence with the Po: a meeting point of routes. (By courtesy of the Touring Club Italiano.)

on the northern side with great and handsome establishments, the most remarkable irrigation in Europe, fruit orchards, mulberry hedges, fields of wheat and of maize, diked and, in the season, flooded rectangles near Pavia for rice. On the southern side there may often be mulberry hedges, and fields of wheat and maize are general; but neither is the irrigation so well developed nor is the cultivation so rich. The farmhouses are often poor and in the poorer parts of the Romagna grade down at times almost into shacks. The verandas of Lombardy are rare here, for the winter is severe.

The towns on the southern side of the Po are mainly of the nature of fall-line towns and have grown up along the Via Aemilia which gives its name, the name of its builder, to the region below the northern flank of the Apennines to which it contributed the germs of unity. These towns vary according to their opportunities and especially according to their trans-Apennine connections, and on this ground Bologna stands out. Rimini has the advantage of being at the sea end of the straight road, and Piacenza is at the Po end of the line. Rimini, like Ravenna, owes something of its strange character to the eastward sea, though its eastern connections affected it chiefly at the end of the Middle Ages and not, as did those of Ravenna, in the days of decline of imperial Rome. Its riverside quays accommodate a few steamers and a fleet of brilliant-sailed fishing boats

that flock out and in according to wind and tide. The south gate of the city, a true and great Roman archway, is surmounted by the proud tooth work in stone of the Ghibellines; and the rough and formidable Malatesta castle guarded the ways from the land where the great isolated hill of San Marino dominates the near view and serves as a reminder of the days when little communities, or their lords, did as seemed good in their own eyes. San Marino's hill is but the greatest of many outposts of the northern flank of the Apennines, and on many another a townlet clusters under a baron's castle with narrow irregular streets that made defense easier in

FIG. 11—The canal connecting Rimini with the Adriatic. Rimini commands the southeastern corner of the north Italian plain: it is at the junction of two famous Roman roads, the Via Flaminia and the Via Aemilia. (By courtesy of the Touring Club Italiano.)

times of street warfare. The ravines of the Apennines have old castles here and there, but the queen of them all on the northern flank is the magnificent eagle's nest of Urbino, standing on an almost isolated spur that looks down on deep ravines for three parts of its circumference and on a fairly low neck for the rest. It owes its special importance to its command of the way through the mountains to its sister fortress of Perugia on the Tuscan side.

Along the Aemilian Way at intervals stand market towns like Cesena, Faenza, and Forli. Faenza is the greatest of these three, because it has ways through the Apennines that are used by the railway, as well as because it has so long had, and is now redeveloping, its tradition of the making of the ware which takes its name "faïence" from the little town. The Roman road runs through each, at times with a slight deflection that is so characteristic, a result of little interferences with the original plan; and there are or have been gates on the great way, mansions near the town center, and a town hall and often a great church on the big market square. But these little towns on the eastern side of the Via Aemilia, as well as Parma, Modena, and Piacenza on the western side, are utterly eclipsed

by the mighty Bologna at the northern end of what has been from Roman times at least, and probably much longer still, the main artery of communication between the Po Basin on the one side and Tuscany and Rome on the other.

Bologna, Mother of Universities

The story of Bologna goes back to Neolithic days at least, but its importance seems to date from the earliest Iron Age and to be maintained

Fig. 12—Rimini: the bridge of Augustus, built 14 A. D. Rimini (Ariminum) was long a frontier station of Rome, the last before the crossing of the Rubicon. (By courtesy of the Italian State Tourist Department.)

through Etruscan and Roman times to the Middle Ages and our own day, with every likelihood of its continuation for an indefinite future. If the university, as already discussed, illustrates the multiple contacts in an, at times, more or less peaceful sphere of activity, the many tall towers of the aristocratic families equally illustrate the warlike contacts at this strategic site; it is a town with a stormy past, with Guelph wresting power from Ghibelline, with a Senate that in good days made much of the Palazzo Communale and a people who not only built the wonderfully decorated Archiginnasio, the Renaissance home of the university, but before that had aspired to build what was to have been the greatest church in Christendom, the immense but incomplete San Petronio in the Gothic style worked out in brick. The mysterious "Seven Churches," so-called, go back to the verge of the Dark Ages; the Middle Ages, century by century, are represented in churches and mansions or fortresses. The Renaissance is everywhere about and hardly anywhere so characteristically as in the arched arcading which shelters the footways along most of the chief streets and makes a contrast with the lack of protection for foot passengers either from carts or from rain in so many other Italian towns.

Summary

With these references to the mother of universities we may close this introduction to the study of the geographic factors affecting the forms and general characteristics of the cities of the Po Basin. In climate and vegetation it is intermediate between the truly Mediterranean lands and Central Europe, in human things it is a region marked out by the rivalry of both from prehistoric times down to the present and the opening future. Structurally a clear unit, its variations of climate and of relations with lands beyond the Alps and the Apennines and the sea have prevented it from achieving any large measure of human unity in face of its axial river barrier. In place of growth towards regional unity we follow, in its story, growth of expression of the city idea. Already strong in Roman times, we see it surviving the Dark Ages and bursting forth again as soon as intercourse is on the way to reëstablishment, and the thought that lands north of the Alps in the Middle Ages were able to buy a good deal, thanks to enrichment from their iron industry, helps us to interpret the special importance of several cities of the Po Basin at that time. Contentions of Papal and Imperial factions, that is rivalry of relations with lands beyond Apennines and Alps respectively, give the cities many features that attract the visitors' interest, and these contentions may be drawn into the argument that seeks to demonstrate the difficulty of regional unity. The relative slowing down of Mediterranean activity after the discovery of America and the Cape route to the Indies left the region to Austria and the Papal States, that is to a continuation of the old thought while France, for example, was enforcing its unity under Richelieu and his successors. Not until the railway epoch did the old scheme finally crumble. That it was the traditional commanders of the northwestern Alpine passes, the House of Savoy, with long habit of diplomacy who became the first rulers of the new unity rather than the lords of the various more commercial cities is a point to dwell upon. The unity remains external and has left the abiding diversities still very strong underneath.

The rise of unity or, at least, the diminution of strife has made possible the increase of attention to cultivation and industry, which has been such a feature for the Po Basin of the last two generations. Swamps are drained and water supplies are reorganized, so that even visitors from northwestern Europe have been known to take no harm from fairly long summer visits to Ferrara and even to Ravenna. Farm buildings and general sanitation improve, and the latter point inevitably suggests the need for a studious survey of the geographic influence resulting from the advance of medical knowledge. Wealth increased up to 1914 and should increase again, and it seemed likely that an old tradition of taste and fineness of work was going to interweave itself with applications of industrial power on the large scale, almost for the first time. Old strong rich

cities and rich agriculture still advancing side by side offer a subject of thought to anyone with a taste for prognostication. Such a one should bear in mind that the new developments do not altogether facilitate the problem of Italian government, the needs of Lombardy and Emilia may with care be met under one and the same system of legislation, but to suit them both and also the region of *latifundia* in southern Italy is another matter. Especially does the problem appear formidable when it is realized that Italian unity is a new thing and that the world's life seems moving away from its satisfaction with the idea of the representatively-governed sovereign nation state built on a basis of linguistic unity. The basin of the Po gives us a picture of another kind, of cities gathering their districts around them, cities which are not merely market towns with a fleeting phase of independence, but which rather show evidences in their monuments and their life of a continuity of culture and a long tradition of sovereignty. It is this feature that makes them contrast so deeply with the cathedral and castle cities, for example, of the Paris Basin.[5]

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[5] H. J. Fleure: Some Types of Cities in Temperate Europe, *Geogr. Rev.*, Vol. 10, 1920, pp. 357–374.

CRATERS OF THE MOON NATIONAL MONUMENT*

By Harold T. Stearns
U. S. Geological Survey

"An area of about sixty miles in diameter, where nothing meets the eye but a desolate and awful waste; where no grass grows nor water runs, and where nothing is to be seen but lava."[1] Undoubtedly Irving's description has reference to the area now known as the Craters of the Moon region of Butte and Blaine counties, Idaho, a part of which is now set aside as a national monument. This region is situated 14 miles southwest of Arco, Ida., at the foot of the White Komb Mountains on the edge of the Snake River plateau, an extensive elevated lava plain covering most of southern Idaho. Westward this plain unites with the Columbia River plateau, and together they form a vast lava field over two hundred thousand square miles in area, surpassed in size only by the Deccan traps of India and the Paraná lava field in South America. The Craters of the Moon region received its name because of the similarity of its topography to that of the surface of the moon as seen through a telescope. The comparison is not highly exaggerated; for the topography, especially in the northern part, when viewed from the top of Big Cinder Butte, is simply a barren, rugged, black surface dotted thickly with pits and craters.

The remarkable phenomenon of the region is the "Great Rift" out of which the lava welled in a series of eruptions that terminated certainly not more than a few centuries ago. The rift begins in the sedimentary rocks in the foothills of the White Komb Mountains and extends for about 14 miles southeastward, whence it enters an unexplored portion of the Snake River plain. It is possible that the craters and black lava 18 miles west of American Falls belong to a southerly extension of this same rift. If so, the rift is over 50 miles long. While such rifts are common in the older volcanic regions of the United States, the surface phenomena accompanying them have been removed because of long periods of erosion, so that the dike, or the feeder, of igneous rock is all that remains. Up to the time of the discovery of the Great Rift, volcanic phenomena that accompany a fissure eruption were not known to exist in this country. Although the area was visited twice by I. C. Russell, who described it as the Cinder Butte region,[2] the rift was not discovered until May, 1921, when Mr. O. E. Meinzer, Geologist in Charge, Division of Ground Water,

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*Published by permission of the Director of the U. S. Geological Survey.

[1] Washington Irving: The Adventures of Captain Bonneville, U. S. A., Hudson edit., New York, 1868, p. 203.

[2] I. C. Russell: Geology and Water Resources of the Snake River Plains of Idaho, *U. Geol. S. Survey Bull. 199*, 1902, p. 72.

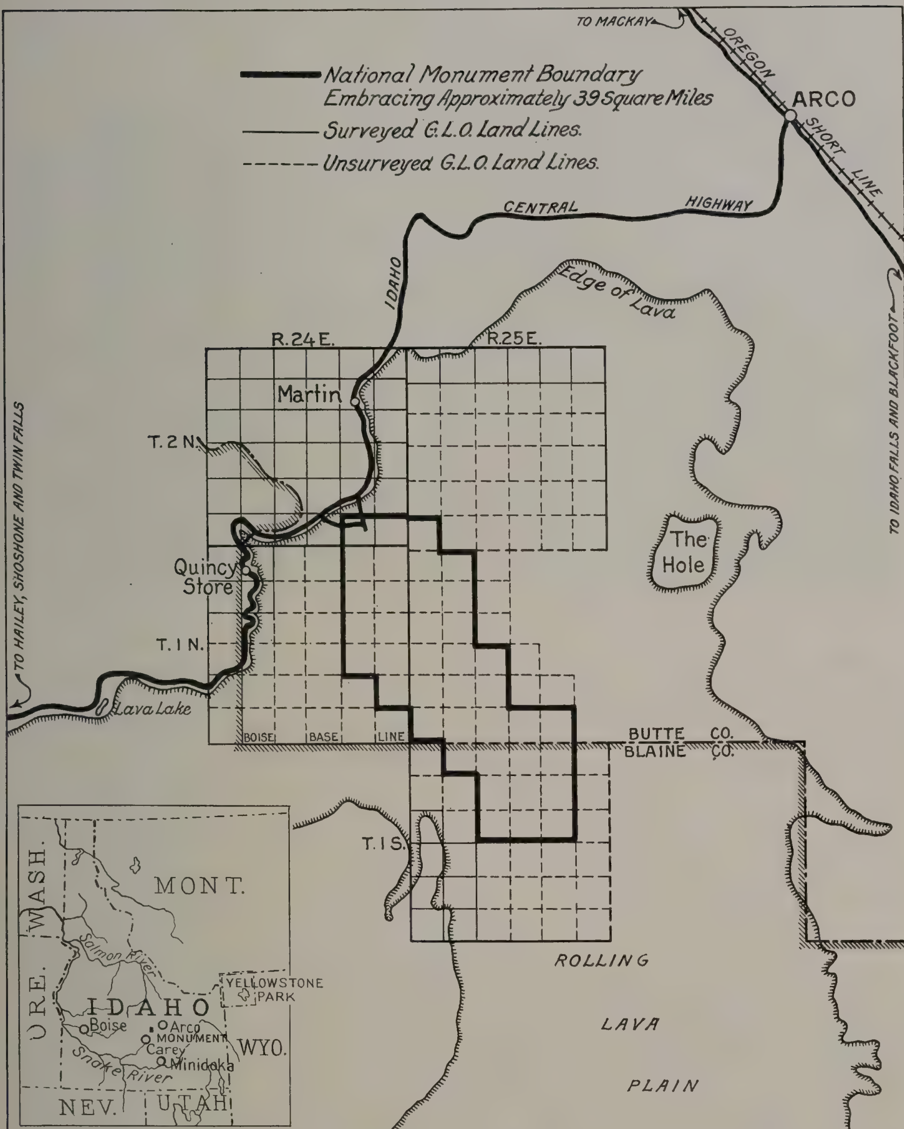

FIG. 1—The Craters of the Moon National Monument, Idaho, from a map by the National Park Service accompanying the proclamation. The inset shows the general situation of the Monument.

U. S. Geological Survey, made a note of it. Following his advice the writer visited the area the same year; but it was not until August, 1923, when Dr. F. E. Wright, of the Carnegie Institution, Washington, D. C., accompanied the writer on a second visit, that the full significance of the discovery was known. Dr. Wright, who had seen similar fissures in Iceland, recognized it immediately as a true fissure eruption. In 1921 R. W. Limbert, of Boise, Ida., visited the area and gave it considerable publicity because

FIG. 2

FIG. 3

FIG. 2—Cinder crags, portions of cones floated away on the surface of a lava flow near the entrance to the Craters of the Moon National Monument. Note that the original stratification is still preserved. (Courtesy of U. S. Geol. Survey. Photograph by I. C. Russell.)

FIG. 3—A row of hornitos along the Great Rift with Big Cinder Butte and its encircling crater rings rising 1000 feet above the plain. The hornito in the foreground is the natural ice well. (Photograph by Harold T. Stearns.)

FIG. 4

FIG. 5

FIG. 4—Looking northeast along the fissure toward Big Cinder Butte, showing the crater pits 10–20 feet deep in the foreground. (Published by permission. Photograph by F. E. Wright.)

FIG. 5—The last trickle of lava that spilled out from the crater of a cinder cone. (Courtesy of U. S. Geol. Survey. Photograph by I. C. Russell.)

of the remarkable caverns, natural bridges, craters, and other features he found there.[3]

Such, in fact, is the unique character of the region that in January, 1924, the writer was asked by the National Park Service to submit a report describing the area, delineating the boundaries, and stating the reasons for its preservation as a national monument. This was done, and on May 2, 1924, the area was created a national monument by presidential proclamation.

General View of the Area

The plant life of the region is scant. The younger lava flows are entirely devoid of vegetation except for a few lichens that cling tenaciously to the barren surface. On the cinder cones there are occasional tufts of wild buckwheat and a few scattered, stunted piñon pines. The older lava flows, however, support a sparse growth of grass, brush, and stunted pines. Animal life is similarly limited. There are a few chipmunks, ground squirrels, rock chucks, and small desert birds. However, people living near the area say that not many years ago the caves and caverns were favorite places in which bear would "hole up" during the long winter months, and here, as elsewhere in our western country, the occasional yelp of a coyote indicates that this nightly prowler frequents the few scattered water holes of the region.

A journey of about ten miles in a southerly direction from Arco through a few irrigated ranches in the valley of Big Lost River brings one to Martin, a solitary outlier of civilization at the foot of the White Komb Mountains. Here is caught the first glimpse of the frozen stream of barren black lava that poured out of a crater along the rift on the hills to the west and flowed down through a near-by valley. On the crest line of these hills, a thousand feet or more above the plain, can be discerned, sharply defined against the white sedimentary beds of the White Komb Mountains, several cones composed of red cinders. Upon leaving Martin, the edge of the foothills is skirted for about three and a half miles, and now and then glimpses of black lava are caught on the east side of the road.

As soon as the area of the Craters of the Moon National Monument is reached the entire character of the topography changes. In front is a vast plain sloping southward from an elevation of about 5000 feet at the entrance of the monument to about 4000 feet above sea level at the southern end. Progressing southward one comes upon a huge black stream of lava spread out on the plain for miles. One is reminded of Thoroddsen's description of the view from the Icelandic volcano, Odádahraun, "the weirdness of desolation itself. As far as the eye can see, the surface of the earth resembles a gigantic stiffened corpse, petrified, black as the night."[4] Although

[3] R. W. Limbert: Among the "Craters of the Moon," *Natl. Geogr. Mag.*, Vol. 45, 1924, pp. 303–328.

[4] Thorvaldur Thoroddsen: Explorations in Iceland During the Years 1881–98, *Geogr. Journ.*, Vol. 13, 1899, pp. 251–274 and 480–513; reference on p. 270.

smooth from the distance, upon closer inspection it appears astonishingly rough, covered with jagged fragments of lava and floated crags of cinders. Continuing southward, one is confronted by cinder cones one after another, large and small, high and low, until one is lost in amazement at their sameness.

From the top of one of the cones, let us say Big Crater, a remarkable view of the numerous craters and their arrangement is obtained. To the east stretches black, barren lava until it fades into the desert haze. Not a sign of life or vegetation breaks the monotony except one small, yellow, grass-covered knoll that was not inundated by the floods of lava and now stands like an island in a black sea. To the west for about six miles the lava has flowed against the southern spur of the White Komb Mountains, filling the valleys as if they were bays and leaving the ridges like projecting headlands in a black sea. Black and barren as it is, the lava surface yet has a weird scenic charm.

To the southeast extends the trough of the Great Rift. In the foreground it is studded with pits, but farther away it opens into dark yawning craters and finally loses its identity in the chaos of high cinder cones. To the northwest the plain is covered with cinder cones, craters, and hornitos, most of which are strung along the trough of the Great Rift. These cones vary in size from small cinder piles 20 or 30 feet high to huge cones which rise a thousand feet above the lava plain. On the tops of many of them crater pits are discernible, especially when viewed under the lengthened shadows of evening. Some of the cones, however, such as Crescent Butte, are merely remnants of larger cones partially destroyed by subsequent explosions.

Unusual Sources of Water

There are no streams in the whole area, the entire precipitation either sinking into the ground or being returned to the atmosphere by evaporation. Nevertheless, water is available to the traveler in several unusual ways. There are three distinct types of occurrence of water in the region. Most striking is the natural ice well near the Bottomless Pit. It is the throat of a small cone on the lava surface with an opening about four feet in diameter. A crude ladder 30 feet long reaches the bottom of the pit resting on a heap of snow about eight feet high. Here on a hot summer day one can refresh one's self with ice water or clean white snow. The bottom of this spatter cone is in the shadow of its walls except for about an hour each day, which is not long enough for the sun to melt the snow of the previous winter.

An interesting spring, which must be supplied by melting ice, occurs about 600 feet southeast of North Crater in the bottom of a pit filled with fragmental lava. On August 25, 1923, the temperature of the water was 34° F. while the air temperature was 87° F. Several other springs of this type are found among the lavas.

A third type of occurrence is that of the lava tunnels. Here the water is due to the precipitation percolating downward through cracks into long tunnels and caverns developed in the lava at the time of eruption. The water collects on the floor of the tunnels in pools; and in winter, when conditions are right for cold air to circulate through the tunnels, the water freezes. In some tunnels ice so formed during winter never entirely melts in summer so that year after year the mass of stored ice increases.

Craters and Hornitos

After the opening of the Great Rift the liquid basalt welled out in tremendous amounts, spreading over the adjacent plains in the form of a huge sheet from 25 to 75 feet thick and covering many square miles. Concurrent with the first welling out of the lava and occupying an important rôle at the close of the period of volcanism, were many explosions along the rift during which ash, cinders, and volcanic bombs were ejected. Evidently some of the explosions were long and continuous while others were very brief. At Big Cinder Butte the explosions must have been on a gigantic scale, although varying in force. They built up a cinder cone 1000 feet high representing about 7,000,000 cubic feet of fragmental lava. Judging from the remnants of the craters encircling it, Big Cinder Butte itself must represent merely the last stage of the eruptions. In the top of this cone there are several crater pits, two of them several hundred feet deep. These are elongated in the direction of the rift.

Evidently slight changes in the fissure caused the point of outflow to shift, and this resulted in the building of successive intersecting crater rings. In some places, as, for instance, in the middle portion of the rift, the lava welled out without actually forming a crater. There is only a band of red scoriaceous lava to mark the site of the fissure. In other places the fissure is marked by a line of cinder pits from 10 to 20 feet deep.

In some cases the lava rose in the throat of the cone until it spilled over the lowest place in the rim, whence flowing down the side it eroded channels several hundred feet deep and floated off on its surface huge fragments of the cone. In other places the lava spilled over the rim of the crater as a mere trickle, not even reaching the plain below.

The structure displayed in the walls of the cinder cones is simple, as a rule. The beds consist largely of cinders and bombs dipping away from the crater and increasing in steepness progressively from the bottom of the cone upwards. Sometimes thin beds of lava are interstratified with the cinders, but generally the structure indicates a continuous explosive eruption either before the lava flowed out or as the last phase of the extravasation.

In some places along the Great Rift, as between Big Crater and Big Cinder Butte, and again at several places south of Big Cinder Butte a row of hornitos was developed. The hornitos are miniature cones from 10 to

Fig. 6

Fig. 7

Fig. 6—Four-ply lava rope on surface of lava flow near Big Cinder Butte. (Published by permission. Photograph by F. E. Wright.)

Fig. 7—Lava mortar showing beautiful rifling in the throat. Near Big Cinder Butte. (Photograph by Harold T. Stearns.)

50 feet high caused by the blowing out of lava by jets of steam or gas. In fact, some of them seem to have been produced by lava fountains such as are frequently seen today at the volcano of Kilauea in the Hawaiian Islands.

In all these features there is close resemblance with the results of volcanism in Iceland.[5] The characteristic terraces formed by subsidence along the sides of the fissures are, however, absent along the Great Rift of the Craters of the Moon.

Detailed Features of the Flows

Both *pahoehoe* and *a-a* lavas are found in the region. The *pahoehoe* lava comprises the streams of lava with broad, relatively smooth surfaces that spread out like thick molasses over the plain. The *a-a* lava was extruded with a high gas content and moved very slowly. As a whole, it is more crinkly, vesicular, and broken than *pahoehoe*. An especially striking feature of *pahoehoe* lava is the ropy structure. While this feature is common in most lava flows, it is here developed almost in perfection.

The lava caves and tunnels are perhaps the most interesting features in the flows. The tunnels were formed when the lava flowed out from under a cooled crust that was strong enough to remain standing. Some of the tunnels in the Monument are 30 feet in diameter and several hundred feet in length. The interiors exhibit beautiful blue and red stalactites and stalagmites of lava. In some caves the stalactites are a foot or more in length, and where the lava has dripped to the floor of the cavern stalagmites equally large have been built up. The walls of some of the tunnels are scored by parallel horizontal lines, marks left by a gradually subsiding river of lava that flowed through the cavern while it was in the process of formation. Large portions of the roofs of these tunnels have fallen, and in some places natural bridges have been formed by a part left standing. The most notable example, known as the Bridge of the Moon, occurs in the southern part of the region.

A peculiar group of surface features is developed southwest of Big Cinder Butte. A few feet from the edge of the fissure there are a dozen little towers of lava from two to five feet high, apparently developed by lava accumulating around jets of steam or gas. The throats of most of those examined exhibited a spiral structure. Similarity of this structure to the rifling of a cannon and similarity in size and shape to the mortars used in the Civil War have led to the term "mortars" for these forms. The rifling is beautifully displayed in the one shown in Figure 7. Others, like the one in Figure 8, show several bores which taper inward and finally unite to form one main tube. The shape of one mortar showed clearly that after the column of steam or gas had quieted down the mobile walls had slumped

[5] Thorvaldur Thoroddsen: Island, Grundriss der Geographie und Geologie, *Petermanns Mitt. Ergänzungsheft No. 152*, 1905, and *No. 153*, 1906.

inward, partially sealing the opening. The bores of the mortars are usually filled with débris from 10 to 20 feet below the surface. The openings probably do not go to great depths and most likely connect with the fissure near the surface.

Lava gutters (Fig. 9) form another curious feature of the flows. These are formed partly by a process of levee building by the lava current and

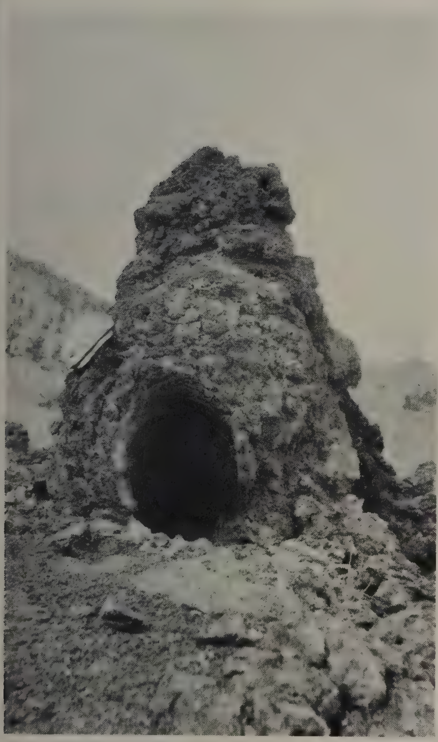

FIG. 8

FIG. 9

FIG. 8—Mortar with two openings which taper inward to unite in one main tube. Black spot on the right is second opening. (Photograph by Harold T. Stearns.)
FIG. 9—Lava gutter near the ice well. (Photograph by Harold T. Stearns.)

partly by channel erosion while the current flows down a relatively steep grade on a partially congealed lava flow. They are usually from 1 to 3 feet wide, from 1 to 4 feet deep, and from 50 to 150 feet long. In some places the liquid lava in flowing through the gutters became cooled at the surface so as to form a crust. In some gutters this crust extended from one wall to the other, forming a slightly arched roof above, while the still-liquid lava beneath flowed out. In this way some of the gutters became tubes or small tunnels. The one illustrated in Figure 9 shows clearly that this gutter had been a tube, but the roof collapsed when the lava finally drained out.

Age of the Lava Flows

It is evident that the eruptions along the rift were spasmodic and occurred during a period of at least a thousand years. Some of the flows in the southern part of the area have a thin mantle of wind-blown soil, whereas in the northern part they are free even from dust and as fresh as though poured out yesterday. Although various guesses have been made regarding the age of the fresh lavas, it is generally agreed that they must have been extruded since the discovery of America. Further evidence will probably be found by a more detailed study of the region. In more humid areas, like the Hawaiian Islands, lava flows only 30 or 40 years old support more vegetation. However, under the semiarid conditions of this portion of Idaho the growth of vegetation cannot be compared with that of the humid Hawaiian Islands.

The Great Rift, with its crater chain, not only exhibits many unusual volcanic phenomena but offers a solution to the problem of how the Columbia River lava plateau was formed. The origin of the Columbia River lavas has always been a problem. Erosion has exposed great thicknesses of lava without, however, exposing a sufficient number of vents apparently large enough to account for their origin. In all probability when erosion has removed the cones and craters of the Great Rift, the solidified feeder of lava that supplied it will prove to be not more than 50 feet in width and possibly only 10 or 20 feet. Some of the small and insignificant dikes that are exposed in the Columbia Basin, therefore, might well be lower portions of a large rift and have supplied the numerous sheets of lava that cover hundreds of square miles.

GEOGRAPHICAL NOTES ON ESMERALDAS, NORTHWESTERN ECUADOR

By Carlos M. Larrea

Some five hundred miles from Panama, on the Pacific Coast of South America, lies a region which may be considered a veritable paradise from the point of view of the beauty of its landscapes, the astonishing fertility of its soil, and its rich minerals. There flourished, in remote epochs, very advanced civilizations intimately related to those of Yucatan and Central America. Nevertheless the province of Esmeraldas is very little known. Although it is so short a distance from the Canal which unites the two oceans; although its coast was the first point of the vast Inca Empire to be trodden by the *conquistadores;* and although from that moment attention was attracted by the wealth of the country and reports of the famous emeralds to which this province owes its name, it remains to the present time one of the least familiar sections of the Republic of Ecuador.

The province of Esmeraldas is the northernmost one along the Ecuadorian coast. On the north is the recently demarcated international boundary with Colombia.[1] Eastward Esmeraldas marches with the Andean provinces of Imbabura and Pichincha, southward with the coastal province of Manabi. The area of Esmeraldas is reckoned at 5500 square miles. Of this the greater part is still unexplored. The small towns—taken together they have in all not more than 25,000 inhabitants—are situated on the coast or on the banks of the large navigable rivers, the only easy means of communication except for a few trails connecting some of the outlying settlements and villages. The extensive plains of the interior between the Rio Blanco and the Guallabamba, the mountainous regions between the Cayapas and Esmeraldas Rivers, the sources of the Rio Verde and the Santiago, and even other parts of the country nearer the coast but hidden under virgin forests remain unknown and for the most part uninhabited, and this in spite of the fact that the province of Esmeraldas has an ample coast line with inlets easy of access and that, as already stated, it is one of the richest and perhaps the most beautiful and splendidly dowered by nature of the Ecuadorian provinces.

Exuberance of the Vegetation and Its Causes

Differing from Manabi and part of Guayas where the vegetation, although most vigorous, loses its beauty in summer when woods and plains are parched by the heat of the tropical sun, the verdure in Esmeraldas is perennial. Furthermore, it extends as a single mantle from the slopes of

[1] The Colombia-Ecuador Boundary, *Geogr. Rev.*, Vol. 11, 1921, pp. 296–297, with map.

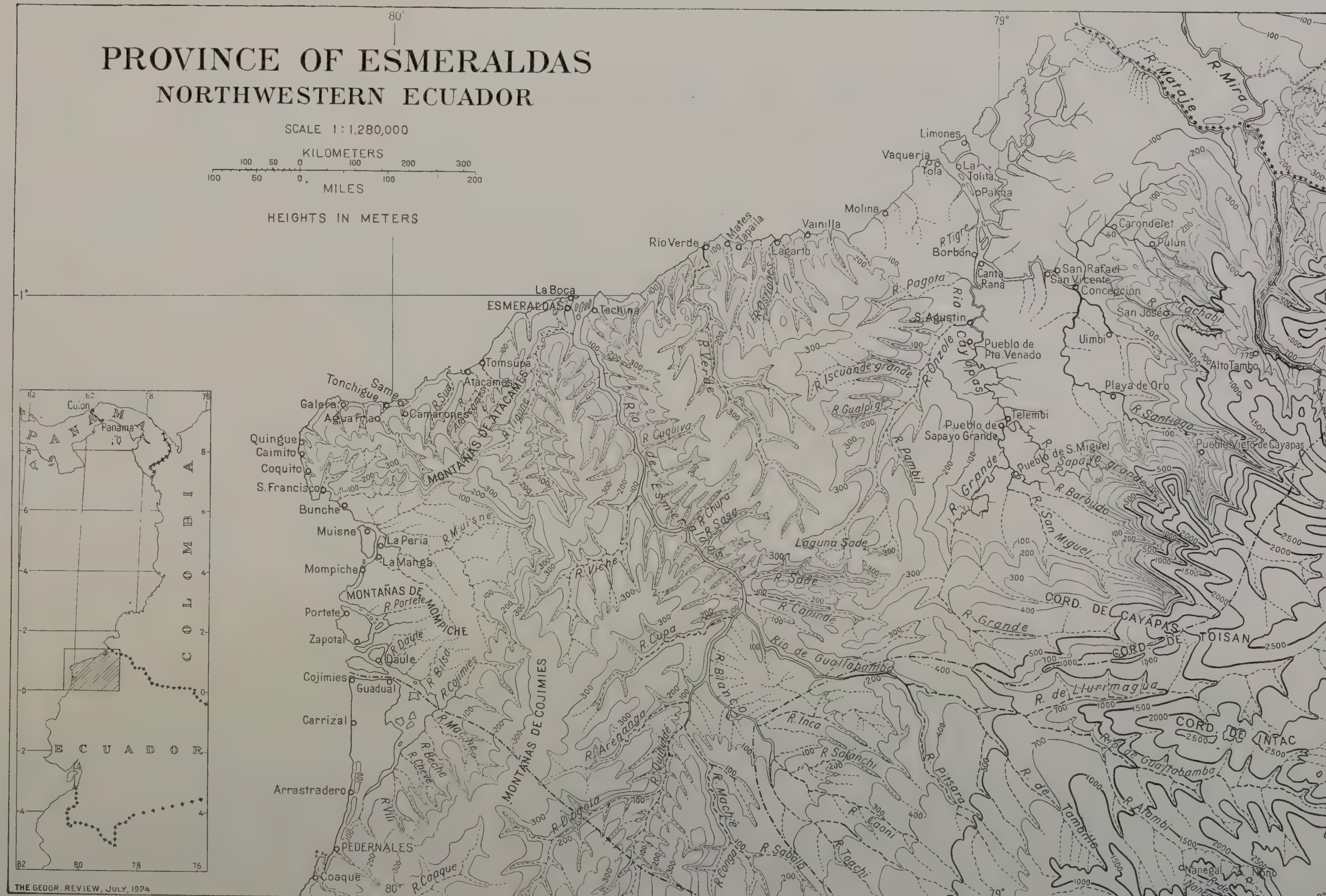

FIG. 1—Map of the province of Esmeraldas, Ecuador, redrawn on a reduced scale from the Esmeraldas-Galápagos sheet of the American Geographical Society's Millionth Map of Hispanic America. The inset shows the general situation of the province.

the Andean Cordillera to the shores of the Pacific. Its exuberance is prodigious. An immense variety of huge trees grow everywhere, and the creepers and parasites on them form veritable awnings. The royal palm and the coconut tree raise their crests to great heights in the midst of innumerable other trees of valuable wood, such as the cedar, the lignum vitae, and the oak, which cover large areas. There together with many species of rattans and canes grow the *pambil* which the inhabitants use for the construction of their houses; the *tagua*, or ivory palm, whose leaves, *cadi*, are used like those of the *bijao* for roofing and whose fruit, the vegetable ivory, constitutes one of the chief exports of the country, averaging 15,000,000 pounds a year; the rubber tree, which was discovered in Esmeraldas in the eighteenth century, and constitutes another great source of wealth;[2] the *toquilla* so valuable in industry (Panama hats); and the *tamajagua* of whose inner bark the Cayapas Indians make their clothing and their bedding. Cacao of high quality is grown, as are balsams, vanilla, copal gum, coffee, excellent tobacco, several different plantains,[3] and an immense variety of other fruits.

The wide plains of the coast only occasionally present the monotonous vegetation of mangrove thickets, flood plains, and marshes. Most of the pampas are covered by the most varied flora—bamboos, shade trees whose trunks are covered by thousands of orchids; and amidst this exuberant vegetation open wide coves with deep and gentle waters where fishing is excellent and boating easy and safe.

Steady Warmth and Constant Humidity

Temperature, humidity, chemical richness of the soil explain the prodigality of the vegetation. In Esmeraldas there are no altitudes like those in the interior of the republic sufficient to modify the tropical temperature which prevails throughout its extent. The climate is therefore hot, but the heat is much less intense than in the other coast provinces thanks to the continuous evaporation from the damp forests. On the seashore (Esmeraldas, Rio Verde, La Tola, Atacames) the temperature does not exceed 80° or 82° F., while in other coast provinces a rise to 91° or 93° is not unusual. In the interior the mean temperature is 72° to 74° and remains remarkably constant throughout the year. The only two seasons distinguishable on the coast are winter and summer, but with this peculiarity that in summer there is more humidity and rains are more frequent. As one proceeds eastward into the interior, along the foothills of the great

[2] In 1736 La Condamine sent to Europe the first samples of rubber, which was discovered in the province of Esmeraldas. He accompanied his shipment with a very interesting memorandum. A detailed account of the discovery of rubber is found in E. Chapel: Le caoutchouc et la gutta-percha, Paris, 1892, and in Henri Jumelle: Les plantes à caoutchouc et à gutta, Paris, 1903, pp. 4–7.

[3] "Their banks [of the Atacames and Sua Rivers] are covered with plantains of which there is no end, which were planted there in heathen times" (Pedro Maldonado: Noticias puntuales de las posesiones y distancias de la Ciudad de Quito, etc., MS. in the National Library of Quito, fol. 243).

See Luis Sodiro: Apuntes sobre la vegetación ecuatoriana, Quito, 1874.

FIG. 2—The Mataje River, which in the lower part of its course forms the boundary between Ecuador and Colombia. (Photograph by M. H. Saville for the Mrs. Marie A. Heye Expedition.)

Cordillera, the difference of seasons tends more and more to disappear so that one may say that in this region there is only winter, that is to say the rainy season.

Contrasts with the Peruvian Coast: Influence of Ocean Currents

We have already remarked on the different aspect of Esmeraldas compared with that of Manabi and Guayas. A little farther south, on the Peruvian coast where it almost never rains, the contrast becomes extreme. The dryness of the Peruvian coast is to be ascribed in part to the cold Humboldt Current.[4] The significance of the difference between the atmospheric temperature and the sea here was pointed out by Wolf and contrasted with conditions in Ecuador.[5] He quotes Humboldt's figures for Callao, temperature of the sea 60°, and of the air 73°, whereas in Esmeraldas the temperature of the sea ranges from 82° to 84°, a degree or two higher than the atmospheric temperature.

The situation of Esmeraldas is extremely interesting in this respect. Two chief currents which follow opposite directions bathe the shores of Ecuador. The Humboldt Current, to which we have referred and which flows along the shores of Chile and Peru, at the latitude of Cape Blanco (4°20′ S.) divides into two arms, one of which follows the coast until near Cape Pasado (latitude 0°20′ S.), while the other turns toward the northwest and the Galápagos. The other principal current comes from the north and is a branch of the Mexican Current, which unites with the West Equatorial and just opposite the coast of Esmeraldas turns toward the west, mingling with the Equatorial Current of the Pacific. Its influence is felt

[4] For a discussion see Isaiah Bowman: The Andes of Southern Peru: Geographical Reconnaissance Along the Seventy-third Meridian, New York, 1916, pp. 125–127.

[5] Teodoro Wolf: Geografía y geología del Ecuador, Leipzig, 1892, p. 385. *Idem:* Apunte sobre el clima de las Islas Galápagos, *Bol. Observatorio Astronómico de Quito*, No. 3, 1879, p. 49. For recent observations on the Peruvian coast see R. C. Murphy: The Oceanography of the Peruvian Littoral with Reference to the Abundance and Distribution of Marine Life, *Geogr. Rev.*, Vol. 13, 1923, pp. 64–85.

FIG. 3—The Mataje River. View from the Colombian side. This forms a panorama with Figure 2. (Photograph by M. H. Saville for the Mrs. Marie A. Heye Expedition.)

in the zone we are studying, especially in the bay of Ancon de Sardinas, which Villavicencio says "is noteworthy for its many currents.[6]

Reference must here be made to another influence of ocean currents of great geographical importance—their effect on the movements of peoples. The influence of wind and currents in the distribution of peoples in the South Seas, for instance, is well known and often described. This same factor should be taken note of in investigating the origin of the primitive inhabitants of Ecuador and their cultural relations. Thus, the province of Esmeraldas lies between two important maritime routes which put it in communication with other regions of the American continent. That part of the coast running from northeast to southwest between the Ancon de Sardinas and Cape San Francisco receives warm waters which bathe the lands of the north, the same that wash the shores where flourished the civilizations of the Nahuas, Tarascos, Mixtecas, Zapotecas, and the Central American cultures. The coast between Cape San Francisco and the province of Manabi, whose general direction is from north to south, feels the last influence of the Humboldt Current.[7] Thanks to this current, boats from the Peruvian coast and from all the Ecuadorian coast to the south of the equator have always been able to reach Esmeraldas without great difficulty, as it is certain they did at the time of the Spanish Conquest. Their return southward was facilitated by the north winds.[8]

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[6] Manuel Villavicencio: Geografía de la República del Ecuador, New York, 1858. Cf. Antonio de Alcedo: Diccionario geográfico-histórico de las Indias Occidentales ó América, 5 vols., Madrid, 1786–89; reference in Vol. 1, p. 92, Ancon de Sardinas.

[7] See Andrés Baleato: La Ciudad de Panama y su distrito, puerto, producciones, y historia, in Colección de documentos, inéditos sobre la geogr. e hist. de Colombia, compiled by A. B. Cuervo, Bogotá, 1892, Vol. 2, p. 347. "From the year 1736 the general direction [of currents] has been known, for ordinarily at the time of the north winds, from Morro de Puercos to the latitude of Malpelo, they flow southwest and west. From the latitude of Malpelo to Cape San Francisco to the east and east-southeast, turning towards Gorgona. From Cape San Francisco they go to the south and southwest until 30 or 40 leagues offshore, and according as the wind is stronger or lighter the movement of the water is more or less rapid. During southerly gales from Point Santa Elena to Cape San Francisco they are north and northwest as far as 30 or 40 leagues out to sea."

[8] "And I saw coming from the shore of the sea a boat which was of great size, which seemed a lateen sail . . . in the which came as many as twenty persons, men, women, and children" (G. F. de Oviedo y Valdés: Historia general y natural de las Indias, 4 vols., Madrid, 1851–55; reference in Vol. 4, Book 43, Ch. 3, p. 121).

The Santiago River in the northern part of the province and the Esmeraldas River in the southern part constitute with their great number of tributaries the two most important hydrographic systems.

The Santiago System and the Cayapas Indians

The Santiago system comprehends four principal rivers, the Cayapas, the Santiago, the Cachabi, and the Bogotá. The Cayapas rises in the mountain range of the same name and in the Toisan range, through a deep gorge of which it plunges toward the plains. Being navigable for a great distance, it is often traversed by the canoes of the Cayapas Indians who live along this river and its principal tributaries. These include the Onzole, almost as large as the Cayapas itself, and the Rio Grande. The Onzole rises near the Sade lagoon, on the watershed between the Esmeraldas and the Santiago Rivers, and drains a great part of the interior. At its mouth, one league from the Santiago, are found the first habitations of the Cayapas. The banks of the Rio Grande, which empties near the village of San Miguel de Cayapas, are populated by these Indians. This is the most interesting ethnographic region for the study of the remains of the Cayapas nation, whose origin and ethnical relations are still obscure. A knowledge of this nation would doubtless throw an immense light on the ancient ethnography of Esmeraldas and the series of civilizations that succeeded one another within its territory.

The Great Sapayo and the Barbudo, the chief tributaries of the Cayapas on the right, are particularly rich in gold. By the latter the Cayapas Indians occasionally travel to the Pinan *páramos* in Imbabura; and this route must be considered one of the means of communication between the seat of Imbabura civilization and that of the mountain peoples of Esmeraldas.

The delightful valleys of the rivers named must formerly have been much more thickly populated, to judge from the remains still existing and from the accounts of the chroniclers and early explorers. Dr. Wolf in 1879 estimated the number of Cayapas inhabiting the banks of these rivers to be between two and three thousand,[9] but there is no doubt that the population has decreased since the time of the Conquest. Even this estimate is larger than that of Don Pedro Maldonado, who speaks of some sixty families, although this may perhaps refer only to those living in the village of Cayapas or San Miguel.[10] But far more noteworthy has been the almost total disappearance of the native populations which formerly lived near the sea. The early chroniclers speak of large tribes dwelling there. Xerez says that there were large settlements with three thousand houses. "And the ships coming from the sea reached the bay of San Mateo

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[9] Teodoro Wolf: Viajes científicos por la República del Ecuador, 3 vols., Guayaquil, 1879: reference in Vol. 3, p. 52.

[10] Maldonado, *op. cit.*, folios 245 *et seq.*

and some villages to which the Spaniards gave the name of Santiago, and the villages of Lacamez . . . which were large and of many and warlike people, for when the Spaniards came within a league of the village in these Lacamez settlements, there came out to meet them more than ten thousand Indian warriors" . . . "village had more than three thousand houses and there were other smaller ones."[11] Dampier even in 1684 found the coast of Esmeraldas thickly inhabited.[12] In 1803 Caldas already laments the disappearance of the populations of Lachas, Puntel, La Tola, and Limones. "We know," he says, "that the mass of population always increases in all parts of the world; why do we find a decrease only among the Indians?"[13]

The destruction of the Indian settlements located in the region lying at the base of the Andes has been attributed to a terrible volcanic eruption,[14] but we believe that this depopulation can be attributed to causes in common operation among primitive civilizations—waves of immigrants arriving in different epochs and destroying the existing settlements or forcing their inhabitants to move to other regions, and continual wars with other tribes and settlements. Whatever the cause, the fact is that immense territories once thickly inhabited are today completely deserted and that only a few miserable villages are left of settlements that were formerly centers of the most advanced civilization developed on the Pacific coast between Central America and Peru.

The Santiago River is navigable for only a few leagues above its junction with the Cayapas; unlike that stream it is a torrent throughout almost the whole of its upper reaches, and its bed at times is constricted. Two leagues above Playa de Oro it is impassable for any sort of boat, since it runs through a narrow canyon with almost vertical walls several hundred feet high. Above them rise the buttresses of the Pinan and Lachas ranges, which are among the least known sections of the province. The few families of Cayapas Indians living on the upper part of the river communicate overland or by the Great Sapayo and Barbudo Rivers with the other little settlements of the tribe. They never descend the Santiago, the middle and lower reaches of which are today populated by some negro families.

Flowing practically parallel with the Santiago and separated from it by a series of low hills is the Cachabi. Like the Santiago, it has a tortuous course and rapid current. It is subject to marked variation in flow, rising sometimes to an extraordinary height as a result of thaws in the Cordillera

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[11] Francisco de Xerez: Veradera relación de la conquista del Perú y province del Cuzeo, in Biblioteca de autores españoles, Vol. 26 (Historiadores primitivos de Indias, Vol. 2), Madrid, 1862, pp. 319–346; reference on p. 321. Cf. Oviedo, *op. cit.*, Vol. 4, Book 43, Ch. 3, p. 123. (Oviedo says "Catamez.")

[12] William Dampier: New Voyage Round the World, London, 1698, Ch. 7.

[13] F. J. de Caldas y Tenorio: Viaje de Quito á las costas del Océano Pacífico, por Malbucho, hecho en Julio y Agosto de 1803, in Obras de Caldas (Biblioteca de historia nacional, Vol. 9), Bogotá, 1912, pp. 107–125; reference on p. 123.

[14] "It [the Pichincha] was said to have erupted in the direction of the land of the Yumbos de Guerra Indians, and buried villages and killed many people among them" (Salazar de Villasante: Relación general de las poblaciones, espagñolas del Peru, pp. 1–41 in Vol. 1 of "Relaciones geográficas de Indias, Perú," 4 vols., Madrid, 1881; reference on p. 27).

FIG. 4

FIG. 5

FIG. 6

FIG. 4—The town hall and plaza, City of Esmeraldas.
FIG. 5—The mouth of the Rio Verde.
FIG. 6—The beach that forms the only highway on the coast between La Tola and Rio Verde. (Photographs by M. H. Saville for the Mrs. Marie A. Heye Expedition.)

Fig. 7

Fig. 8

Fig. 9

Fig. 7—The hacienda of Pampa de Oro, La Tolita (delta of the Rio Santiago).
Fig. 8—Tolas, artificial mounds, at La Tolita.
Fig. 9—Cayapas Indians on the Rio Santiago. (Photographs by M. H. Saville for the Mrs. Marie A. Heye Expedition.)

and at other times falling so much that the inhabitants along the banks have to drag their canoes across bars of sand and gravel. The Bogotá unites with the Cachabi a short distance above its junction with the Santiago half a league above the town of La Concepción. This stream, which rises in the plains of the northeast of the province, is deep and gentle, lending itself to navigation by boats and barges.

Below La Concepción, the Santiago is a broad, deep, and majestic stream until, divided into many branches and leaving a great number of islands in its midst, it empties into the ocean. The chief of the islands in the delta of the Santiago are La Tola, Santa Rosa, and San Pedro—all very important from the archeological point of view.

Throughout the greater part of the basin auriferous deposits are found. In these washings the gold is found mixed with platinum and small amounts of osmium, iridium, palladium, and rhodium—a circumstance worthy of notice because analysis of many antique gold objects found in this region has given the same results as that of samples from the washings on the Santiago. The same has been observed in the analysis of platinum objects and of the remarkable alloys of gold and silver with this metal, which was unknown in Europe before the eighteenth century.[15] This proves that the interesting objects found in the graves of the Esmeraldean coast were made by the aborigines and not acquired through commerce with other civilized countries.

The Esmeraldas Basin

Towards the south of the province we find the second river system whose great artery is the Esmeraldas River. Differing from the Santiago by the extensive ramifications that make this system the greatest of those on the Pacific slope of the Republic, it differs no less in the character of the region drained. Whereas the entire lower basin of the Santiago lies in Pleistocene and recent deposits, much of the Esmeraldas basin is developed in Tertiary formations, and a part of the Esmeraldas and Guallabamba valleys is occupied by a volcanic tufa, which evidently originated in the inter-Andean volcanoes in post-Pleistocene time. In the snows of the Andean Cordillera are found the sources of this system, whose principal branches are the Blanco and the Guallabamba. The Rio Blanco rises on the western slopes of the Pichincha. In the mountainous and almost unexplored region of its upper reaches it receives the waters of the Toachi River, which comes from the high mountains to the west of Latacunga and Machachi, and of the Yambe, whose source has not been explored. Farther on the Caoni enters from the right. This region, in which there are many ruined fortifications and archeologic remains, deserves a careful study; unfortunately it is as yet almost unknown. From the entry of the Caoni on, the Blanco

[15] A proof of the great progress made by the Esmeraldeans in the art of working metals is the different alloys with platinum. Wolf says in this connection: "I have never seen such a variety in shades of gold, from the lightest to the darkest, and certain mixtures surprised me especially because I do not believe that they have previously been observed in American antiquities" (Wolf, Viajes cientificos, Vol. 3, pp. 50–51).

has a broad valley; its channel widens considerably and frequently divides into arms which surround picturesque islands. The principal tributary of the Blanco, the Quininde, comes from the south through a somewhat narrow but deep channel favorable to navigation and one which must formerly have served as a means of communication between the settlements of the interior and the coast provinces.

FIG. 10—The Rio Atacames near the town of Atacames. (Photograph by M. H. Saville for the Mrs. Marie A. Heye Expedition.)

The region traversed by the Blanco is beautiful and is rich in fine woods, rubber trees, and ivory palms. With its tributaries, also navigable, the system constitutes the easiest means of communication between the interior of this province and the mountains of Manabi and Santo Domingo. These latter are the abode of another important tribe of Indians, known as the Colorados. From their language and ethnical characteristics we must consider the Colorados closely related to the Cayapas.

The Guallabamba gathers all the waters of the inter-Andean valley in the province of Pichincha and opens a path to the west through the gorges of the Puellaro, Perucho, and Niebli. At the base of the Andes the current remains very rapid, and along the winding channel in this part of its course may be seen many little barren islands of gravel supporting only a straggling vegetation.

Rather more than 40 miles from the sea the Rio Blanco and the Guallabamba unite under the name of Esmeraldas. The great river at this point again enters a mountainous region extending without interruption to the coast, and the basin is correspondingly narrowed. Its banks present the most varied aspects as hills and ridges follow each other in quick succession. The Esmeraldas does not form a delta like the Santiago, but in its wide mouth islands and shoals are formed whose shape and location the swift current is continually altering.

For a distance of 125 kilometers the coast on both sides of the river's mouth consists for the most part of rocky declivities and in many places of high cliffs, broken here and there by the ravines of rivers which have their source in the low-lying regions near the coast or in the mountains of the southernmost part of the province.

Rivers of the Littoral

The principal rivers of the littoral district, beginning from the south, are first, the Cojimies, a river system of some importance with its multitude of little tributaries which rise in the Cheve, Mache, Cojimies, and Mompiche Mountains. These ranges surround the wide plain in the center of which lies the Gulf of Cojimies. The shores of the gulf were formerly inhabited by a numerous people with an art differing in some respects from that of the aborigines of La Tola. Northward is the basin drained by the winding Muisne and its tributaries and bounded to the north by the Atacames Mountains. The coast of these two valleys, which are separated by the Mompiche Mountains, is low, and at the mouth of the rivers we have just named are islands and sandbanks similar to those of La Tola.

From Cape San Francisco on, the coast, as we have said, is high and rocky. Between this sort of rampart and the sea is a sandy beach along which one may pass at low tide. Further on we find the Atacames River, near the mouth of which lies the ancient and once important settlement of the same name. The Atacames region has a special archeological importance. Between the Esmeraldas and the Santiago and almost parallel with the former flows the Rio Verde, the largest of the so-called littoral rivers. Finally, north of the Santiago the Mataje River empties into Ancon de Sardinas Bay in the northern part of a labyrinth of inlets that form the end of the low plain of San Lorenzo and La Tola.

Prehistoric Remains in the Coastal Region

Traces of ancient peoples are found along the whole coast of Esmeraldas and especially near the mouths of the rivers. "In many places," says Señor Portes in a memorandum addressed to the government in 1837, "for league upon league the ground is covered with pots, jars, and grotesque figures of colored clay, some whole, some broken. The farmer's wooden shovel is continually striking against buried jars which contain

human skeletons, axes of hard stone, chiseled with the delicacy of a modern lapidary, stilettos and other implements of copper, as hard and perfect as the steel ones in use today, although of a different type."[16] Real banks of fragments of pottery mingled with human remains, ashes, and shells are found in many places both in the region bounded by ravines and high rocks and in the other which is covered in part by thickets of mangrove trees and which includes a multitude of channels and islands. Of all these deposits, only a few have as yet been studied. At the mouth of the Tomsupa River, five miles north of Atacames, there is a great mound of fragments of pottery and pieces of jars among which are found many gold and platinum objects. In Tonchigue, fifteen miles south of Tomsupa, the expedition led by Professor Saville found a layer of pottery twenty inches thick and four hundred feet long.[17] On the right bank of the Atacames the floods of the river have laid bare another great bank containing an enormous deposit of human remains, great jars, pots, and tubes of clay.[18] Dr. Wolf found thread, wire, and little plaques of gold and alloys of this metal with others in a ravine a little south of the site of Lagarto, east of Punta Verde.[19]

Generally all these objects are found at no great depth beneath the surface and in soil of modern alluvial formation. In the few cases where they are found at a considerable depth or under the sea or resting on soil of tertiary marine formation, it is due to the redistribution of the material by sea and rivers. These processes are helped by a slight degree of subsidence in progress, but much more important are the ordinary processes of erosion. In the memorandum of Señor Portes, quoted by Ceballos, we read: "From the inroads which the sea has made during the six years I have lived here, one may notice that during the last century it has usurped some 400 rods of the coast. There are residents of La Tola who remember having seen houses where boats now anchor, and it is probable that this village itself will disappear in a few years because it is easy to observe how much the sea is eating into it."[20]

Theories attributing a great antiquity to these deposits of pottery and human remains are very questionable. The soil itself of the northern beaches where these archeological objects are found is very modern, and at this day the configuration of some of the islands and points at the river mouths is constantly changing. The archeologist should keep geological phenomena well in mind while studying the various deposits of objects that reveal the existence of prehistoric man. A great number of terra cotta vases and human and animal figures, stone implements, and metal ornaments are also found in the artificial mounds abounding in the northern part of Esmeraldas.

[16] P. F. Ceballos: Resumen de la Historia del Ecuador, Guayaquil, 1889, Vol. 6, p. 184.

[17] M. H. Saville: Archaeological Researches on the Coast of Esmeraldas, Ecuador. *Verhandl. des XVI. Internatl. Amerikanisten-Kongresses, Wien, 9. bis 14. Sept., 1908*, Vienna and Leipzig, 1910, pp. 331–345, reference on p. 337.

[18] *Ibid.*, pp. 337–338.

[19] Wolf, Viajes cientificos, Vol. 3, p. 50.

[20] Ceballos, *op. cit.*, Vol. 6, p. 186

The environs of La Tola, the island of the same name, and above all the island of Santa Rosa, where La Tolita is situated, are extremely rich fields for the archeologist and contain abundant material for study.

This name of La Tola is due in reality to the structures raised by the aborigines and called "tolas," artificial hillocks similar to the "mounds" of North America and like them of varying dimensions and forms, the most common being the conical, or hemispherical, and the rectangular in outline.

These hillocks abound in that region and are found along almost the whole of the Ecuadorian coast. In the interior the region of the mounds is confined to the province of Imbabura and a part of Pichincha,[21] but these mounds differ in many respects from the earth and stone structures of Manabi and Esmeraldas.[22]

Relation with Other Civilizations

What was the relation between the mound builders of the Imbabura region and those of the coast? Does the difference in the art, which indicates two entirely different civilizations, mean also an essential difference in the origin of these peoples? What was the relation of the mound builders of Ecuador to the Chibcha peoples, to whose linguistic stem must be referred many of the geographical names of the region in which these monuments are found and the Cuaiquer, Cayapas, and Colorado languages? In the indubitable succession of civilizations and immigrations that occurred in the province of Esmeraldas, to which one may we attribute the introduction of this type of structure, and what place belongs to the Cayapas?

To the Atacames or Esmeraldeans of the coast Buchwald attributes the mounds of Samborondon between Guayaquil and Babahoyo and others in the province of Los Rios.[23] What was the ethnographic extent of this people whose progress in the arts, especially in pottery, is so surprising? These are problems of the greatest importance for Ecuadorian prehistory, and we hope they will gradually be solved.

The greater part of the vast and beautiful territory of Esmeraldas is arable, and the exuberance of the vegetation everywhere proves the fertility of the soil. The aborigines therefore were able to obtain with little trouble and in great abundance the elements necessary to sustain life. But this same facility bestowed so prodigally on them by nature hampered the development of certain arts and industries. Thus we shall seek in vain in Esmeraldas for the remarkable works for the cultivation of the fields that were accomplished in pre-Columbian epochs in the arid coasts of Peru.

[21] Cf. Federico González Suárez: Los aborigines de Imbabura y del Carchi, 2 vols., text and atlas, Quito, 1908, 1910, reference in text, p. 11; *Notas Arqueologicas*, Quito, No. 8, p. 73, No. 10, p. 114; Jacinto Jijón y Caamãno: Contribución al conocimiento de los aborigines de la provincia de Imbabura en la República del Ecuador (Estudios de prehistoria americana, Vol. 2), Madrid, 1912, p. 298.

[22] See C. M. Larrea: Otto von Buchwald—Tolas ecuatorianas, *Bol. Soc. Ecuat. de Estudios Historicos Americanos*, Vol. 1, 1918, pp. 64–69. In this article the author names the principal works dealing with the Ecuadorian mounds.

[23] Otto von Buchwald: Tolas ecuatorianas, Buenos Aires, 1917, p. 8.

Neither are there irrigation canals, since the humidity is excessive; nor shelves and terraces, since the plains are immense and the undulations of the ground gentle; nor causeways and roads, because the navigable rivers offered quicker and easier transportation. On the other hand the fishing industry must have been very well developed; remarkably perfect boats were built; and the arts of pottery and metallurgy were far advanced in the period when the coast peoples flourished. The hot climate was doubtless one reason why the textile arts did not reach a high stage of perfection, but the use of ornaments and jewels, beautifully wrought, was very common.

At the present time the cities of the coast enjoy the advantages of civilization and modern progress. The capital of the province, also called Esmeraldas, is a picturesque port which is united with the rest of the world by cable and wireless, but toward the interior there still remain the unexplored solitudes of the forests among which flow copious rivers carrying grains of gold and platinum.

ROCK CREEP ON MT. KTAADN, MAINE

By Edward S. C. Smith and Philip W. K. Sweet

Mt. Ktaadn is situated nearly at the geographic center of the State of Maine in Piscataquis County in a practically uninhabited region. As it is thirty miles from the railroad and difficult of approach, to make a protracted stay at the mountain one must be prepared to rough it with the camping equipment that may be packed in on horseback. Recently, however, lumbering operations have reduced the distance over which pack methods must be employed.

No good topographic map of Ktaadn has yet been made, but the broader features are shown on the hachure map (Fig. 1) which accompanies this paper. As seen from the south (Fig. 2) the mountain rises abruptly from a general level not exceeding a few hundred to 5273 feet above the sea. On the northeast, north, and northwest appear other mountain groups such as Turner Mountain, Wissataquoik Mountain, Mt. O J I, and others, though none of these compare in height or extent with Ktaadn. At only short distances either side of the mountain flow the east and west branches of the Penobscot River, both of which were used as avenues of approach to it in the early days and still are favorite routes.

Early Ascents

Numerous excursions took place in those earlier days, and there is much of historical interest attaching to Ktaadn in this connection. In fact, a volume might be written concerning those pioneer ascents, and it may be well to review some of the outstanding ones. The earliest recorded ascent of the mountain was made in 1804 by Charles Turner, Jr., and party. Turner was engaged in his duties as a land surveyor. It appears that the Indians of the vicinity, Penobscots and Abnakis, believed the mountain the lair of an evil spirit whom they called Pamola; and never would an Indian ascend higher than the tree limit for fear of this monster. Nevertheless, the Indian guides of Turner's party went to the top, apparently willingly, after they found the white men determined to go. The name Pamola is at present applied to one of the lesser peaks of Ktaadn.

During the northeastern boundary controversy we find that the mountain was ascended in 1819 by Colin Campbell, one of the surveyors employed by the British Government. In 1836 Professor J. W. Bailey of West Point and Professors Keely and Barnes of Waterville (now Colby) College visited the mountain. The following year Dr. Charles T. Jackson with a party climbed Ktaadn in a snowstorm while performing his duties as first State Geologist of Maine. In 1847 an ascent was made by the Rev. Marcus

R. Keep, Home Missionary in Aroostook. A born naturalist with a great love for the out of doors, he neglected no opportunity to further his knowledge of the wilderness in which he found himself placed, and his name will always be linked with Ktaadn. It was he who accompanied Charles H. Hitchcock about Ktaadn in 1861 at the time of the second geological survey of the state. In the summers of 1873 and 1874 Merritt C. Fernald, at one time President of the University of Maine, made expeditions to Ktaadn which resulted in the first reliable determination of its height, previously believed to be much over one mile. Fernald's determinations gave about 5215 feet as the altitude. Subsequent measurements show the true elevation as 5273 feet.

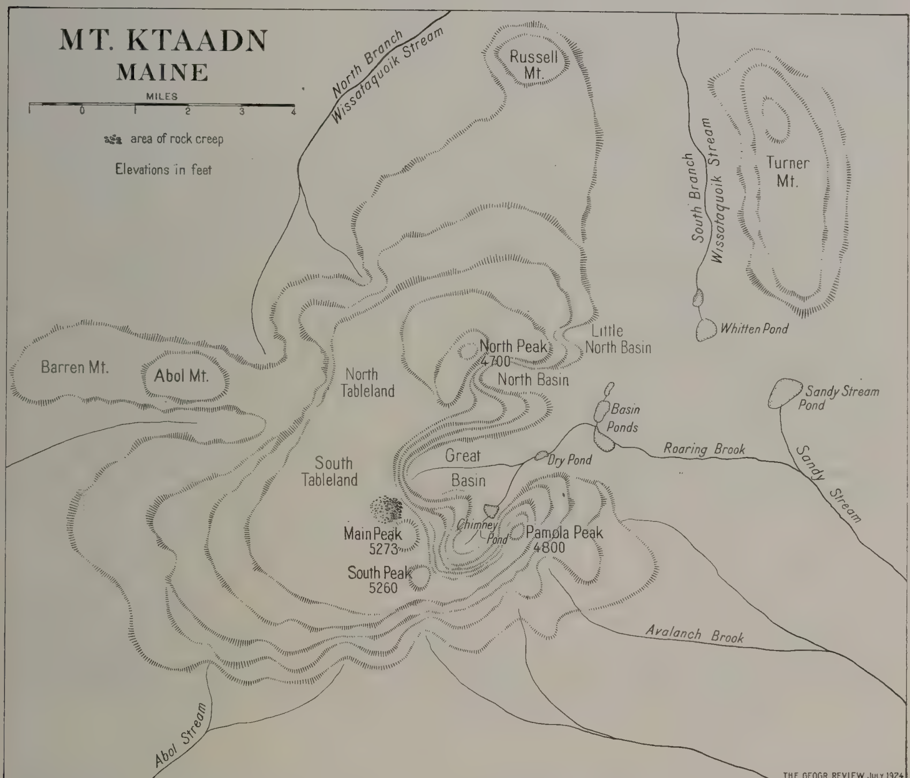

FIG. 1—Map of Mt. Ktaadn showing position of the area of rock creep and other general features.

Topography of the Mountain

It was the privilege of the writers to visit this region in August, 1923, and carry out a study of the bed rock geology already contemplated for several years. At the same time observations were made upon the rock creep which is taking place over a large area on the upper portions of the mountain. As this phenomenon is not one which may be said to be of com-

mon occurrence, this opportunity is taken to present the facts in brief form.

As both C. E. Hamlin[1] and R. S. Tarr[2] have given excellent descriptions of the topography of the mountain, it will be sufficient to say here that Mt. Ktaadn may be considered as a part of a great granite batholith which has been only slightly dissected into the several mountain groups mentioned above; Ktaadn itself remains as the largest mass. The mountain has suffered erosion by ancient valley glaciers as well as from the last con-

FIG. 2—Mt. Ktaadn from the south. (Photograph by Call, Dexter, Me.)

tinental ice sheet. At the present time streams are in a limited way assisting in dissection, and the atmospheric agencies are very active. Both mechanical and chemical weathering are proceeding rapidly.

Glaciers and streams have carved a number of spurs running out from the main portion of the mountain, the so-called table-land whose elevation is about 4300 feet. From this table-land the upper slopes to the various peaks are relatively gentle, probably about 1500 feet to the mile as an estimate in absence of instrumental determinations.

Rock Creep and Its Cause

It is upon the slope on the northern side of the main peak that an example of rock creep such as is peculiar to semiarctic regions is to be seen.

[1] C. E. Hamlin: Observations Upon the Physical Geography and Geology of Mount Ktaadn, and the Adjacent District, *Bull. Museum of Comp. Zoöl. at Harvard College*, Vol. 7 (Geol. Series, Vol. 1), 1880–84, pp. 189–224.

[2] R. S. Tarr: Glaciation of Mount Ktaadn, Maine, *Bull. Geol. Soc. of America*, Vol. 11, 1900, pp. 433–448.

FIG. 3

FIG. 4

FIG. 3—"The Knife Edge," the upper walls of the Chimney Pond cirque. (Photograph by Call, Dexter, Me.)

FIG. 4—General view of the slope on which the principal creep is taking place. (Photograph copyrighted by W. F. Dawson, Lynn, Mass.)

Here an area some acres in extent is covered with a mantle of rock of this nature. Essentially all the material has resulted from the disruption of the Ktaadn granite along its joint planes and is well sorted; the larger and more massive fragments are found nearer the summit and source of the rock, the smaller farther down the slope. Passing downward, the rock fragments are seen to become distinctly subangular and in rare cases actually rounded. The condition of subangularity is less apparent towards their source. Certain parts of the mass tend to radiate tongue-like and resemble a rock flow. One of these tongues is especially prominent and extends for thirty or forty feet. Occasionally it is possible to see the rock fragments a foot or so deep far down the slope; and, thinning radially, they thus approach the true rock flow. Such observations make it quite evident that there has been a movement down grade under the influence of gravity which has resulted in reciprocal abrasion and rude sorting.

It is well known that in mountainous regions where a considerable degree of cold prevails for the greater part of the year rock creep or flowage may go on at such a rapid rate that vegetation of any kind is prevented from gaining a foothold. Such conditions obtain in certain parts of the Ktaadn rock flow. The creep, or flow, is due primarily to the action of the frost which forms underneath boulders or pebbles. The expansive force of the freezing water lifts the rock a small but definite distance from the ground. As this lift is in a direction at right angles to the inclination of the surface on which the fragment rests, and the eventual melting of the ice crystals allows gravity to act in the true vertical, the boulder or pebble is thus advanced forward and down the given slope. This action repeated many times will serve to transport fragments of even considerable size long distances provided the angle of depression remains sufficiently sharp.

The rock flow examined occurs, as we have said, on the north-facing side of the main peak, exposed to cold winds and frost for the greater part of the year. In addition, a wide daily range of temperature obtains in all seasons and aids very materially in the disintegration of the granite. Actual observations of temperature differences on the main summit between sun and shade at noon in September have shown fifty Fahrenheit degrees.

The granite of the upper sections of the mountain shows three well developed sets of joints nearly at right angles to one another, which results in the formation of rectangular, sometimes cubical, joint blocks and offers an excellent opportunity for frost work. It is probable that during the late fall and early spring, when alternations of freezing and thawing go on apace, the larger prisms are detached from the parent ledge. Such an effect is to be observed on a grand scale at the upper walls of the cirque at Chimney Pond and has been referred to by Tarr in another connection. No doubt the blocks are often temporarily held in a position of instability awaiting only the melting of the ice to allow gravity free play. It is not difficult to imagine that, in the course of freezing and thawing, a not inconsiderable movement of such blocks will take place and, having once

started, will tend to keep in motion. The larger and more angular pieces will be moved only slowly at first: however, exfoliate weathering occurs to some extent, and, as their contours become more rounded, transportation takes place without much difficulty. Further, the slight mutual concussions tend towards the same end, thus making for a greater ease of movement. The rate at which fresh material is being added to the Ktaadn rock flow is now much slower than it must have been formerly, and the chief interest at the present time is centered not in the derivation of this material so much as in its downward sweep across the slope.

In a region which has had a fair share of valley as well as continental glaciers, it is only pertinent to consider whether or not such a deposit as above described might be explained on the basis of glacial action. That we are not dealing with the phenomena of valley glaciers is quite obvious because of the location of the materials, and it is also difficult to understand how an otherwise impartial continental ice sheet should have failed to make other similar deposits elsewhere about the table-land where the granite was equally available for attack. Further, it is generally conceded that the transporting power of the continental glacier was considerably reduced as it rode over the tops of mountains as high as Ktaadn. The material lacks the characteristics of any sort of moraine. Finally one may ask why, under glacial conditions, the rock fragments would be noticeably larger in the direction away from that in which the ice moved. Actual proof of flowage is found beside a few of the larger boulders where streams, if we may use the term, of rock have swept around them or in rare instances have been pushed up on them. Several cases of larger fragments being buried by the smaller ones were noted.

In conclusion, it is believed that the rock mantle described has resulted from the disintegration and subsequent creep down grade of joint blocks and their autoclastic derivatives, that it is post-Pleistocene in age, and that the chief activity now is the creep or flow of the more or less rounded boulders, pebbles, and coarse gravel.

It is believed also that the condition described is rare, perhaps unique for New England; no others are known to have been described from the higher mountains of that region.

THE ECONOMIC ACTIVITIES OF THE FALKLAND ISLANDS

By Clarence F. Jones
Clark University

The Falkland Islands, lying far down in the South Atlantic, 1000 miles south of Montevideo and 480 miles northeast of Cape Horn, are a frontier station of the habitable world. Here many South Polar expeditions have made their last stop and stocked up with provisions before the final dash for Antarctica and lands unknown. The islands constitute one of the more isolated places of the world; their communication with the outside depends upon steamers which call once a month on the outward and homeward passage between the United Kingdom and the west coast of Chile and Punta Arenas. On the other hand they occupy a significant location as the only oceanic way station relatively near the Magellan Strait route.

Settlement of the Islands

The first recorded discovery of the Falklands was by Davis in 1592, and the islands were visited by Hawkins two years later. However, it was not until the mid-eighteenth century that an interest in their strategic location was manifested. In 1764 France took possession of them, but two years later she sold them to Spain who valued them as a possible victualing station for her vessels bound for Peru and Chile. The Spanish founded a fort on East Falkland. Simultaneously the English formed a settlement on West Falkland. In 1770 the Spaniards dislodged the small English garrison. Restitution was made by Spain the following year, but active occupation ceased shortly. Subsequently the Spanish settlement was abandoned too. It was revived in 1820 by the young republic of Buenos Aires only to be broken up by an American ship of war in a controversy over seal fisheries rights in 1831. In 1832 Great Britain took final possession of the group, planted settlements, and in 1843 organized a crown colony here. Among the arguments set forth and accepted, when this step was under consideration, were the advantages that would accrue to British merchant shipping plying round Cape Horn and to the South American Squadron of the Royal Navy operating on either side of South America. The recent war proved the soundness of the reasoning, even for modern conditions, and emphasized the strategic character of the islands and the value of Stanley Harbor as a place of refuge, an excellent naval base, and an outpost of the Pacific. The latest stage in the political development of the colony was the creation of the Falkland Islands Dependencies by Letters Patent in 1908 and 1917.[1] This is the

[1] Compare the creation of the Ross Dependency, *Geogr. Rev.*, Vol. 14, 1924, pp. 314–315.

Antarctic sector comprising the islands and territories between 20° and 50° W. longitude south of 50° S. latitude and between 50° and 80° W. longitude south of 58° S. latitude (see Fig. 1), notably including South Georgia, the South Orkneys, the South Shetlands, the Sandwich Islands, and Graham Land.

The Falkland Islands, consisting of two large islands, East and West Falkland, and approximately one hundred smaller ones, comprise an

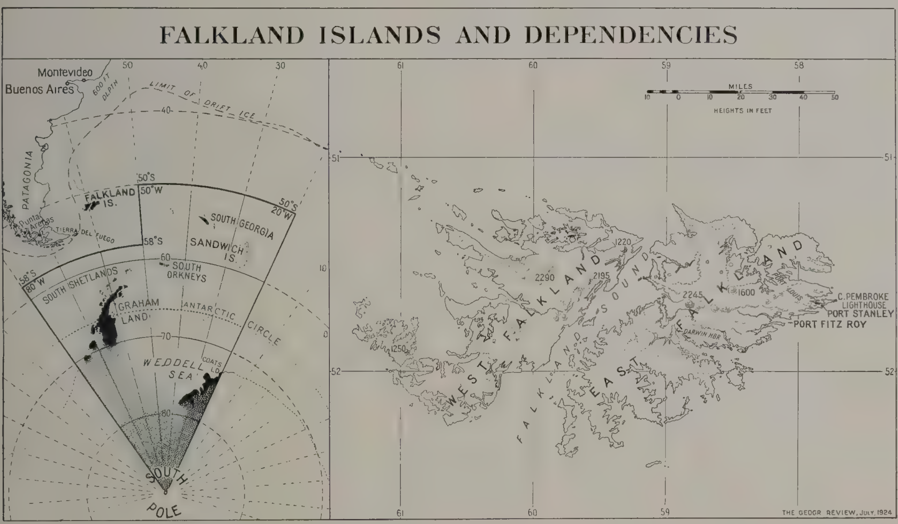

FIG. 1—The Falkland Islands and Dependencies. The larger map shows the Islands on the scale of 1 : 4,000,000 approximately. The smaller map shows the Dependencies (the "islands and territories" included within the sector bounded by the heavy line) in relation to the Islands.

area of 6500 square miles. They are therefore about the size of the Hawaiian group; but, whereas the balmy tropical air and fertile lava soils of those modern Islands of the Blessed support a population of a quarter of a million, the Falklands give poor subsistence to a scant population of 2300 souls. Seen as a whole, the major islands may be described as bleak, treeless, rolling moorland interspersed with gray rock ridges or jagged hills, which here and there rise to the height of 2000 feet or more (Fig. 1). In some places peat bogs and swamps are extensive while in others, where sheep have destroyed the grass, drifting sand adds the final touch of desolation. The peaty soils and the cool climate favor the growth of a coarse grass fairly well suited for sheep.

The Sheep Industry

For many years the principal industry, sheep raising now engages the attention of two-thirds of all the people on the islands. Almost the whole country is parceled out into farms or sheep runs, which are held by some thirty farmers and farm companies. The carrying capacity of the range

is relatively small, and the ranches are correspondingly large, varying from 1500 to 700,000 acres. A very large one grazes 200,000 sheep. Not all of the land, however, is suitable for grazing purposes. In total only two-thirds of 2,325,000 acres is in pasturage.

Other conditions influence directly the type of sheep raised. The ground is never dry and subjects the sheep to the foot rot disease, which is fatal to most breeds. Further adaptation is necessitated because of the climate.[2] The Falkland Islands lie in a belt of extraordinarily persistent storminess. One cyclone follows another in quick succession, the usual summer "let up" of the westerlies belt in the northern hemisphere being unknown. The amount of sunshine is small. Rain falls on more than 243 days of the year with maximum in summer and autumn, though the annual rainfall barely exceeds 20 inches, for most of the rain comes as mist and drizzle and light showers. The relative humidity is always high, varying between 72 per cent for January and 91 per cent for June and July. The range of the temperature is not great. The average temperature for January, the warmest month, is 49° F. and that for July 37° F., although summer temperatures may rise to 73° F. and those of winter drop to 22° F. The islands are washed by a cold current[3] and the mean annual temperature is comparatively low, 43° F., slightly below that for the Faeroes, in a latitude 10° higher.

In this prevailingly raw, cloudy, windy, and moist climate only hardy sheep of the greasy crossbreed variety will thrive, a breed in which the Romney Marsh characteristics predominate. The islands support 668,000 head of these sheep, which produced nearly 5,000,000 pounds of wool in 1920. Owing to climatic conditions, this wool has remarkable and distinctive properties; the fiber has a fine texture and a light specific gravity, which makes it especially valuable for hosiery and finger-yarn articles.[4]

Each of the large sheep ranches has its headquarters consisting of the manager's house, cookhouse, wool sheds, and sheep pens at a settlement situated on a good harbor of the highly articulated coast. The little huts of the shepherds are scattered about the large farms. In many cases a whole small island constitutes the farm, and its only human inhabitants are the man who owns or manages the island, his wife and children, and his few employees. There are no roads on the islands. In many areas the jagged rock ridges are difficult to traverse; in others, extensive stretches of moss growth form treacherous bogs, in which many a horse and rider have lost their lives. These difficulties render traveling hazardous and force it to be made entirely on horseback or on foot. Overland communications are reduced to the minimum. On the other hand, freight, mail,

[2] C. E. P. Brooks: The Climate and Weather of the Falkland Islands and South Georgia, *Geophys. Memoirs No. 15*, Meteorol. Office, London, 1920, pp. 95–146. Discussed by C. F. Brooks in the *Geogr. Rev.*, Vol. 11, 1921, pp. 626–628.

[3] R. C. Mossman: Las condiciones físicas del Atlántico sur entre el Río de la Plata y las Islas Orcadas del Sur durante el verano, *Oficina Meteorol. Nacl.*, Buenos Aires, 1922.

[4] The Empire's Trade in Wool in Its Relation to the Wool Trade of the World, *Bull. Imperial Inst.*, Vol. 16, 1918, pp. 476–515; reference on p. 483.

and passengers are carried by water between the different parts of an island and between the numerous islands by the Falkland Island Transport Company. The fiord coast, with indentations extending far inland, brings all parts of the large islands near water routes (Fig. 1). Yet the maintenance of interinsular communication is attended with difficulty because of high winds, rough seas, and rock-bound coasts. The steamship *Falkland* leaves Port Stanley monthly, within 72 hours of the arrival of the mail vessel from England, to call at various points on the islands.

FIG. 2—A sheep station on West Point Island (latitude 51° 20′ S., longitude 60° 40′ W.). Stations are located on or near the coast because all transportation is by water. (Photograph by Rollo H. Beck, of the American Museum of Natural History.)

The boat distributes the mails and the imported food products, clothing, and building materials to the settlements and picks up the wool, hides, and skins, which go to Port Stanley for export.

The Export Trade and the Whaling Industry

In spite of the dominant importance of sheep raising on the Falklands, wool comprises only eight per cent of the total value of the exports (1920). The paradox is explained by the economic sphere of influence of Port Stanley. Wool is a local product; the bulk of the export from Port Stanley is constituted by whale produce (chiefly oil) derived from the seas of the Dependencies, around South Georgia and the South Orkney Islands more

than 1000 miles away. The exports of whale oil in 1920, a typical year, amounted to ten times those of wool in value and 16.8 times in weight.

The whaling industry of this area in its present dimensions dates only from the beginning of the present century. In the old days of deep-sea whaling the species hunted were limited to the sperm whale—which was the source of spermaceti oil—the bowhead, and the right whale. Before the invention of the steam whaler and the harpoon gun in the sixties of the last century, difficulties in the way of capture and reduction rendered impracticable the hunting of other species, although several were capable of yielding whale oil. The introduction of shore whaling made it possible to take these "finner" species, among which are the humpback and finner whales, so abundant in the region of the Dependencies. The new method has been developed largely by Norwegians, who in pursuit of their ancestral tasks have settled in Port Stanley or live in the temporary whaling colonies in South Georgia.[5] The industry employs about 600 persons of the Falkland port and 1000 men on the Antarctic littoral during the whaling season. There are 21 companies operating in the region of South Georgia; fourteen of these work from Port Stanley as a base, and the others, from northwestern Europe, operate primarily through Port Stanley. The industry is carried on by large companies chiefly because of the remoteness of the fishing grounds, the recent development, and the type of whales taken.

Port Stanley, while 1000 miles from the whaling grounds, lies far to the south of any other adequate port that could serve as an outfitting point for the fishing fleets. The harbor affords protection in all sorts of weather. It has regular communication with the United Kingdom, where most of the whale oil is sold. Being a coaling and supply station it can provision the ships engaged in whale hunting.

South Georgia and the South Orkneys have a more rigorous climate than the Falkland Islands; they are smaller and more rugged, unfavorable to permanent settlement. Attempts have been made to raise sheep, especially in South Georgia, but without success. The western slope of this island is permanently snow-covered down to 2000 feet above sea level, and glaciers fill all the valleys. However, the eastern slope, swept occasionally by warm dry *föhn* winds from the mountains, is almost free from snow. The South Orkneys, South Shetlands, and Graham Land are generally ice-covered and enclosed by packs and are practically useless even as shelter for whalers.

Whaling operations are carried on primarily during the summer months (October to March) because whales are more plentiful and climatic conditions more favorable at this season than at any other time, though even

[5] T. E. Salvesen: The Whale Fisheries of the Falkland Islands and Dependencies, in "Rept. on the Sci. Results of the Voyage of S. Y. *Scotia* during the Years 1902, 1903 and 1904 (Scottish Natl. Antarctic Expedition)," Vol. 4, Zoölogy, pp. 479–486, Edinburgh, 1915.

Rept. of the Interdepartmental Committee on Research and Development in the Dependencies of the Falkland Islands, Presented to Parliament, April, 1920, Cmd. 657, London, 1920.

in summer whalers must endure disagreeable weather and rough seas. Moreover, the season in the more southern district around the South Shetlands and the South Orkneys lasts but two or three months, according to the proximity of the ice pack.

When a whale is caught, the oil is taken and the bones and meat are converted into fertilizer either on a floating factory in a harbor or in a land factory on South Georgia, which has several of these large establishments.[6] The floating factories, mostly old passenger steamers converted for the purpose, are fitted with boiler digesters and can be operated at far less expense than a land station. They are sent out to the whaling grounds both from Europe and Port Stanley.

The Import Trade

The imports amount to only one-fourth of the total trade of the Falkland Islands. Four classes of commodities make up four-fifths of the imports: coal and coke, 50 per cent; groceries, 20 per cent; hardware and machinery, 7 per cent; and structural timber, 5 per cent. The important place of coal and coke is due to the large demands and the lack of available fuel. There is neither coal nor wood in the islands, and the constant humidity of the air prevents the drying of peat. Fuel is needed in all the houses throughout the year because of the prevailingly cool, moist climate. It is consumed in the three canning plants that dispose of the surplus sheep, by the many vessels that coal at Port Stanley, by the land whale factories on South Georgia and the floating whaling factories, some of which are equipped at Port Stanley, and in the ship repairing industry of this port.

Most of the foodstuffs required by the islanders must be imported. Only about 150 acres are under cultivation, for the most part experimental oat fields. The results, while somewhat encouraging, indicate only limited development along this line. Wheat will not ripen at all, and barley and oats rarely mature properly. Vegetables can be produced only with difficulty. Therefore every article of food except mutton and penguin eggs is scarce (Fig. 3). Milk and other dairy products are hard to procure, and fresh vegetables—even cabbage and potatoes—are largely a luxury. Sheep cannot be grazed successfully on the same pastures with cows, and fencing materials are costly. Consequently many farmers make no attempt to keep cows. Moreover, because of the remoteness of the islands, only certain commodities—breadstuffs, canned goods, and dried fruits—which can be transported long distances without noticeable depreciation, enter into the trade.

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[6] J. Q. Dickson: The Empire's Outpost in the South Atlantic, *United Empire*, Vol. 7 (N. S.), 1916, pp. 161–172, London. Noted in *Geogr. Rev.*, Vol. 6, 1918, pp. 286–288. See the illustration of Leith Harbour, Figure 1, and the whaling station at King Edward Cove, South Georgia, Figure 2. For some new and excellent illustrations of harbors and whaling stations of South Georgia see Commander Wild's book "Shackleton's Last Voyage," noted in this number of the *Geographical Review*.

Hardware and machinery are important in the trade because the Falkland Islands do not possess raw materials, power, capital, or skilled labor. Nearly all of the newcomers to the islands are shepherds from the British Isles. They earn $44 a month, with food and housing supplied; and when reverses come in the sheep industry, rather than enter some trade for which there is scope, they proceed to Tierra del Fuego or to Patagonia to take up similar work.

The case of lumber and timber products is similar to that of coal and coke. No lumber is produced in the islands, and a constant demand for it exists. The headquarters buildings and the shepherds' huts on the sheep stations and many of the houses in Port Stanley are constructed of imported timber products. Structural timbers are required constantly in connection with the ship-repairing industry of the port.

Port Stanley

A fraction of over one-third (900) of the people of the Falkland Islands reside in Port Stanley, the only town in the islands and the headquarters of the colony since 1844. It is on the leeward side of East Falkland and stands on the southern shore of an almost landlocked harbor three miles long and one-half mile wide. Along the waterfront are many old ships moored in the harbor and used as storehouses. On either side of the harbor, rock ridges rise to considerable heights and, with the narrow opening, afford protection from all winds (Fig. 1). This sheltered harbor, lying in the path of the westerlies from Cape Horn, is the refuge of many a sailing vessel and numerous steamers battered and crippled by the stormy seas of that region. There is hardly a month, even at the present time, when one of these disabled ships does not find its way into Port Stanley either to be refitted and repaired for further voyage or to be condemned as unfit for service and remain as one more of the many victims of the sea interned there. Stranded sailors and their descendants form an appreciable proportion of the population. These persons work at ship repairing or engage in fishing on one of the floating whale factories, many of which are patched up and fitted out in the ship-repairing yards.

The Future of the Colony

There seems to be little opportunity for further development of the sheep industry. Several small islands that have not been settled may afford new pasturage. On the other hand, the carrying capacity of the ranges in the older districts seems to be on the decline. As a matter of fact, when the sheep industry in 1867 was established on a permanent footing, tussock grass, excellent for grazing purposes, grew on all the islands. To this grass was due, in part, the great increase in the number of sheep—35,000 in 1867, 283,000 in 1877, 563,000 in 1887. In 1896 a record total of 801,000 was reached. Since then the numbers have been on

FIG. 3

FIG. 4

FIG. 3—Collecting penguin eggs on Kidney Island (north of Cape Pembroke). Penguin eggs form an important source of food in the islands. A government license is necessary for the privilege of collecting the eggs, and some colonies are seldom disturbed. (Photograph by Rollo H. Beck, of the American Museum of Natural History.)

FIG. 4—Kidney Island, the Falkland Islands. A Penguin colony. In the background is tussock grass, which supplies a hay crop from the smaller islands. Overgrazing on the larger islands has destroyed this grass. (Photograph by Rollo H. Beck, of the American Museum of Natural History.)

a fluctuating decline. At present the total head of sheep is about 668,000. The tussock grass, originally a valuable food, has been almost eradicated from all the larger islands by overgrazing. The cool, peaty soil now supports only a poor growth of tawny grass, which has little nutriment for cattle, but on which sheep do fairly well. The ranges are now stocked to capacity. During the last few years two canning factories were established to utilize the surplus sheep. In addition, some overstocked ranches are sending them to Punta Arenas in Chile and to Buenos Aires.

Some development may be expected along other agricultural lines—the growing of vegetables and the production of dairy products. Potatoes, carrots, turnips, cabbages, Scotch kail, and rhubarb may be produced even in the face of unfavorable conditions. The difficulty of raising even these vegetables is the damp, cold, peaty nature of the soil. All the gardening soil is artificial.

Dairy products might be produced in larger quantities. There are about 5500 cattle in the Falkland Islands. Most of these are at the various sheep stations, but some still run wild. The production of a local supply of milk and butter at the various stations involves the fencing of pastures for the cows, for they do not thrive on pastures grazed by sheep, and the storage of a forage crop for winter feed. Difficulties are met in connection with both these projects owing to the lack of fencing material on the islands and the high price of the imported article and to the disappearance from the large islands of tussock grass, the only herbage that furnishes a hay crop. However, the smaller islands where there are no sheep supply a good hay. Moreover, fair crops of oaten hay can be produced in East and West Falkland, and oats have been successfully used as ensilage.

The ship-repairing industry of Port Stanley has shown a tendency towards decline during the last few years. This has been due to the high cost of lumber and repairs at that port, and to the scarcity of labor; many ships avoid the Falkland Islands and make for Montevideo in case of trouble. Many of the younger men, in recent years, have gone to Patagonia and Tierra del Fuego, and large numbers of the elder members of the community have retired to the British Isles.

The fishing industry is susceptible of considerable development. The whaling industry of the Dependencies, it is true, cannot increase markedly and indeed can approximately maintain its present status only with scientific investigation and development. On the other hand, the physical conditions of the sea between the Falkland Islands and the east coast of South America are such as to support large numbers of fish. The depth of the banks admits of fishing operations. The sea temperatures are not unlike those on the northern fisheries; the region witnesses a meeting of cold and warm currents. The fact that the waters off the Falkland Islands and southern South America support quantities of seals and penguins, beside other birds (Fig. 4), presupposes the existence here of at least a fairly large number of fish. Moreover, direct observation has shown the presence

of edible species, while shoals of fish resembling small herring are reported from Port Stanley. Whether these fisheries will be developed from the Falkland Islands as a base or from Chile, Argentina, and Uruguay will depend on the countries engaged in the fishing operations and on the market regions. Recently these latter countries have taken initial steps for such development. Uruguay has established a fishery institute with the object of developing the industry in a scientific manner and has installed large refrigeration plants. If the fisheries are worked by these countries, little profit will accrue to the Falkland Islands from them. The Falkland Islands have an excellent location for operations on the banks but lack a population with a natural aptitude for the industry. The young men, accustomed to life in the sheep stations, rather than change their occupation migrate to Chile or Patagonia. In all probability, therefore, the Falkland Islands will take at best a minor part in the development of these fisheries and will derive little advantage from their exploitation by other countries.

THE GARDENS OF THE FAEROES, ICELAND, AND GREENLAND

By John W. Harshberger
University of Pennsylvania

Greenland and Iceland in the minds of most persons are associated with barren mountains, frozen plains, and inhospitable conditions generally. But we are beginning to realize that the arctic and subarctic regions are not altogether desolate wastes, that their short summers may be pleasant and the wild animal and plant life abundant. Gardens in Greenland and Iceland, are they possible? Svend Bruun and Axel Lange answer the question affirmatively by the last three sections of their attractively illustrated book "Danmarks Havebrug og Gartneri til Aaret 1919."[1] We are introduced to these far northern gardens by way of the Faeroes.

The Faeroes

A delightful article in the *Atlantic Monthly* for May, 1921, tells of a little garden far up in the sixtieth degree of north latitude on one of the Faeroe Islands:

> In front of the cottage is a large bed of perennials with a little golden locust tree on the upper border. The taller plants are lilac and white lupines, a flowering currant, a foxglove or two, cottage lilies, yellow larkspurs, and one of bright blue monkshood, montbretia, monkey flowers, Jacob's ladders, Shasta daisies, feverfew, mauve and white rockets, doronicums, fair-maids-of-France, an oriental poppy, two peonies, and starry astrantiums. The lower plants are sweet Williams, pyrethrums, lilac and white horned violets, forget-me-nots, potentillas, Iceland poppies, a bleeding heart, Scottish bluebells, geums, catchflies, daffodils, Spanish irises, spiraeas, and wood hyacinths.
>
> And then there is the border. First, a wonderful band of primroses. Never, no, not under Devon hedges, have I seen such a wealth of blossoms, hardly a leaf showing among them. Then comes a band of London pride, or *Saxifraga umbrosa*, or mother-of-thousands, as you choose to call it. And the inner band is poet's narcissus. . . . There are gravelly paths that curve and wind down the slope, as paths should do. . . . They pass under the tiniest trees and between the biggest currant bushes that I have ever seen, and lead to a storehouse, or to a sheltered nook among elderberry bushes, where there are benches and a table."[2]

Hans Kristoffer's earlier gardening was one of trial. Denmark and Norway contributed some plants. Southernwood came from the Shetland Islands, and later came contributions from a Scottish border garden. Few survived when sent from English gardens.

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[1] Svend Bruun and Axel Lange: Danmarks Havebrug og Gartneri til Aaret 1919, Copenhagen and Christiania, 1920.

The writer has drawn freely from a translation of the three chapters made for him by Mrs. W. C. Plummer of Philadelphia, permission having been obtained previously from Axel Lange and the publishers to use this material.

[2] Elizabeth Taylor: The Garden of Hans Kristoffer, *Atlantic Monthly*, Vol. 127, 1921, pp. 639–648; reference on pp. 640–641.

Scholars are at variance as to the origin of the name Faeroes. But whether it is derived from sheep or not, certain it is that all the islands are teeming with these creatures, and whatever parts have been brought under cultivation have been laid out essentially for pasture. Sheep raising is not consistent with gardening, as might be expected. The gardens must as a matter of course be limited to the country districts and hamlets which lie near the sea, and everything is on a small scale. The gardener is confronted by severe conditions. Cold is not the worst enemy of plant life. The Faeroes have comparatively a mild insular climate, and the sea never freezes over. The wind, which often earns the name of tempest, or better, hurricane, is far more destructive. Shelters are sorely needed, but the low stone walls, which are found almost everywhere and which are primarily intended to guard against wandering sheep, poorly protect the trees, bushes, and hedges. Hedges in general grow so poorly that they need protection themselves. The Faeroe Islands are the most sunless region in the world. Only five days in the year average an entirely cloudless sky, and as many as one hundred and eighty-four days on the average report a completely clouded sky. As a consequence there is very little summer heat. July in the Faeroes is no warmer than is April in Denmark; and, as the summer is of short duration, the shoots of the trees ripen with difficulty, and only the very hardy kinds can survive the winter. In shelter various kinds will thrive, because there is nothing the matter with the soil.

The parts of the trees and bushes that rise above the stone walls or other shelter are fully exposed to the spring frosts and the sharp winds. The trees make little progress in their struggle upwards; their tops are filled with dry, decayed branches; the whole growth is low, twisted, and dwarfish. The Swedish service tree, or Scandinavian mountain ash, is said to be the only kind whose shoots are not killed in the severest winters. One sees this tree everywhere in the Faeroes, while the somewhat less hardy common ash seems to be more scarce; this is also the case with the other trees which are planted: the birch, large-leaved elm, maple, and larch together with evergreens—white spruce and mountain pine. Of the trees with acicular leaves, the mountain pine is considered the hardiest, and this does not freeze. The beech trees are seen in solitary places and can under good conditions reach a height of three meters. A maple tree eight meters high, the circumference of whose trunk is one meter, is considered the highest tree in Thorshavn and the entire archipelago. The willow in the indigenous flora is represented by the golden osier, *Salix phylicifolia*, but these and other planted kinds are found as bushes.

Fruit trees are entirely lacking. Of fruit bushes currants thrive best, and with sufficient shelter the berries ripen regularly every year. Gooseberries are unreliable but give at least green unripe berries and are used as ornamental bushes, whose early leaves enliven the desolate garden in the spring; the older bushes become quite large with rich foliage. Black currants ripen very seldom and raspberries never. The largest berry

harvest is obtained from the wild berry-producing plants—red whortleberries, blueberries, and crowberries. The people of the Faeroes do not care for ornamental bushes that take up too much space. The friends of flowers take more pleasure in the perennial plants that acquire an amazing size and an abundance of flowers which, in the moist, cool air, long preserve their freshness. It is only within the past twenty or thirty years that the people of the Faeroes have learned to value vegetables. When Rostrup[3] visited the islands the Kvan (*Angelica archangelica*) gardens were almost entirely neglected. The angelica gardens are in many places replaced by cabbage gardens. Of the different kinds of cabbages the cauliflower is the one which prospers best. Stalks of kale break easily in winter in the furious storms. Some of the root crops do well. The cultivation of potatoes has spread fast, but the potatoes must be treated as premature kinds and must be sprouted before planting out in the fields or gardens.

In the "Description of the Faeroe Islands and the Inhabitants of the Islands" written in 1673 by the Dane Lucas Debes,[4] who for many years was minister and teacher in Thorshavn, there are found but few lines on the condition of horticulture in his time. "Here grow both food plants, namely turnips, carrots, cabbages, lettuce, cress, savory, and other such things and many different kinds of wild plants." There were also named some plants of the wild flora, such as sorrel, pepperwort, and scurvy grass, adapted to counteract the common sickness, scurvy. Nearly 120 years later there was published a new description of the Faeroes. This also was written by a Danish minister, Jørgen Landt, who for a time had been stationed in Thorshavn. His "Attempts at a Description of the Faeroes"[5] is still an important primary source. In it he says: "The garden is a neglected institution in the Faeroes. It is really only the people of Thorshavn who, encouraged by the example of the sheriff and the governor, have some appreciation for gardening. In the country only the ministers, as a rule, have gardens." From the plant school at Frederiksberg were sent fruit trees, which blossomed nicely the first summer; but the joy they occasioned was shortlived. The fruit fell off some of them unripe, and the following winter every one of the trees died. "Of all that had been planted outside of the garden, I did not see a trace."

After the years 1899–1900 more progress was made in tree planting. In 1902 John Paturson in Kirkebø, who was then a representative from the Faeroes to the Storting, turned to the Danish Society for Cultivation of Heaths with a request to have a man sent to the Faeroes who should examine conditions there for the growth of trees. After uphill work the nursery was established, and in 1910 the first sowing was undertaken. Many good mountain ashes, maples, and firs have been sent to different places in the Faeroes but not with much success. What the summer builds up,

[3] E. Rostrup: Færøernes flora, *Botanisk Tidsskrift*, Vol. 4, 1870–71, pp. 5–109.
[4] Lucas Debes: Færøa veserata eller Færøernes oc Færøeske Indbyggeres Beskrifvelse, Copenhagen, 1673.
[5] Jørgen Landt: Forsøg til en Beskrivelse over Færøerne, Copenhagen, 1800.

the following winter destroys. Tree planting has been supported by subscription from the parliament of the Faeroes and the Danish administration. That hedges should ever become of great significance is improbable; the stone walls and other shelters are better as they are not affected by wind and weather in the same degree as trees and bushes.

The wild flowers of the Faeroes have been particularly well investigated. Landt[6] has a list of the flowering plants of the Faeroes, 203 kinds in all; then later Rostrup's description appeared;[7] and still later we have had the greatly needed "Botany of the Faeroes,"[8] 1901-1908, published in English. Most of the plants in the Faeroes are also found in Denmark. Of the most northern kinds several have their southern limit in the islands. They are found on the highest mountain tops. Not even the angelica in its northern form is supposed to grow any farther south than the Faeroes. Its history cannot be considered to be fully cleared up as yet, but it is possible that it was found growing wild in the islands before they were settled. Debes puts it down as common. "Here is found a great quantity of angelica, called Kvan, not only in the gardens or churchyards, where it is planted, but also in many places in the wild woods and on the high mountains."

Iceland

Reference to a map of the North Atlantic Ocean will show that the northern part of Iceland just touches the arctic circle and is placed athwart the twentieth meridian of west longitude. It has been isolated from tourist travel; but within the last year or two the summer trips by steamer from New York to North Cape have been arranged so that American travelers can visit Iceland and see its geysers and other scenic features on the outward passage to the land of the midnight sun.

Iceland has long been settled: the date can be given definitely as between the years 874 and 930. Settlements were made on the much diversified coast and in the deep fiords, especially of the south and west coast, whose climate is influenced by the Gulf Stream. The ruins of farmhouses and the continuity of northern agriculture down to the present indicate that the Norse methods of farming, and no doubt the home horticulture likewise, were transferred to Iceland. The old sagas mention the plot of ground, Kvanhaven, in which angelica was cultivated. Consumers of angelica were eager to try the cultivation of their plant in Iceland, for once established it perpetuated itself and could be had readily when needed. There is now no occasion for its special cultivation, for it is found in abundance all over the island. In the gardens cabbages and other more useful plants have taken its place.

The surface area of Iceland, a little under 40,000 square miles, is about three times that of Denmark, but the proportion cultivated is small.

[6] *Ibid.*

[7] *Op. cit.*

[8] Eugen Warming, edit.: Botany of the Faeroes, Based upon Danish Investigations, Copenhagen and Christiania, 1901–08.

The whole of the interior is occupied by barren mountains, snow fields, lava deserts, and heaths. Along the coast is found the arable land, and the population is distributed accordingly.

Formerly gardens were almost entirely lacking or were limited in their cultivation to angelica, but appreciation of horticulture has grown, the use of garden produce has now greatly increased, and various effective forces are at work to deepen the interest in flowers and vegetables to a still greater extent. Reykjavik has naturally been the principal seat for work in gardening, though the capital, occupying an open position, lacks the natural shelter which is the foundation for horticulture in Iceland. Akureyri, the leading city in the north, is far more favorably situated from the horticultural point of view. In the very heart of the fiord, sheltered by the mountains, it enjoys as good conditions as are offered anywhere on the island. However, during the long severe winters the ice packs itself along the northern coast, and its effect is felt over the greater part of the island. Then, if the short summer is late, plant life suffers accordingly, and even the potato crop for which Akureyri is noted, is a failure for the year.

From primitive beginnings the art of gardening had a slow but steady advance, as the perception dawned that there were many plants that could be grown successfully in Iceland. Much of the improvement was due to the interest taken in the enterprise by the Danish government and by the Royal Danish Agricultural Society established in 1769. A little before this time an account of the agricultural state of the country was given by Bjørn Haldorsson, pastor of a northwestern parish.[9] Haldorsson struggled tirelessly for the advancement of gardening and sought during the many years he spent in his Icelandic parish to convince every one he could of the absurdity of the widespread idea that Iceland could not produce vegetables and root crops. And he saw his work rewarded. "Many farmers in his parish and some people of distinction farther away, have from his instruction laid out gardens and have come to use potherbs." Haldorsson was Iceland's pioneer in the cultivation of potatoes, and in this he was seconded by the Agricultural Society.

In the late summer of 1758 Bjørn Haldorsson received a half bushel of potatoes, which were planted in the spring of the following year; and four weeks later he had the pleasure of seeing a crop grow up from them. The potatoes grew well, but it was difficult to get people to eat them. When Bjørn Haldorsson for the first time placed his potatoes, prepared like a porridge, on the table in his home, his family refused to taste such food. Hard was it to encourage the raising of vegetables, which were strange to the meat-eating people of Iceland. "It seemed strange to the simple common people that they should eat grass contrary to the custom of their fathers," complains Bjørn Haldorsson.

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[9] Magnus Olafssen: Korte Beretninger om nogle Forsøg til Landvæsenets og i sær Havedyrkningens Fremgang i Island, Copenhagen, 1761.

In 1770 an "Icelandic Garden Book,"[10] was published and to the number of a thousand copies, probably the whole issue, was distributed free of charge. The publisher explained that the work was intended "for the meditation of my countrymen, the ignorant Icelandic farmers," and pointed out that this garden book was the very first of its kind arrayed in Icelandic garb. Two years later the Agricultural Society again distributed gratis in Iceland five hundred copies of a little work, "On the Culture and Use of Potatoes."[11] Two years later still, in the year 1774, another Icelandic garden book was published.[12] This work also, which was prefaced with a long commemorative poem, was distributed to the number of five hundred copies in different parts of Iceland. In appearance and subject matter the first two Icelandic garden books resemble each other greatly. Both treat exclusively of vegetable gardens and, after the custom of the time, give aromatic herbs, of which a small number grew in Iceland, a comparatively prominent place.

Under his latinized name, Olaus Olavius, Olaf Olafsson wrote an essay, "On the Natural Products of Plant and Animal Life in Iceland Most Worthy of Encouragement," which was published by the Agricultural Society.[13] It treats also of vegetables and praises Jerusalem artichokes for their usefulness. The angelica, which is called by its prevailing popular name, Ætihvønn (Spisekvan), receives mention; and there is recalled the old edict in the law books, "Graagaas," according to which any one who takes angelica from another's land shall pay a fine of six shillings.

In a work published late in the eighteenth century "Attempt at an Icelandic Natural History,"[14] we read about early experiments in gardening in Akureyri. The merchant Lynge's improvements are praised not only because of his potherbs but also because he was supplied with flowers—wallflowers, lupine, mignonette, goldthread, and others. Indeed, according to reliable reports "a modern pear was supposed to have been grown in the same garden." The tree with this wonderful, solitary fruit died later, but the fame of the pear had already spread widely.

In the year 1883 George Schierbeck, doctor and horticulturist, gratefully remembered in both capacities, took up his work in Iceland. He laid out his lot of ground of 4000 square ells in Reykjavik for experimental cultivation on an extensive scale, surrounding it on all sides with a six foot wall of planks as a protection against the biting winds to which Reykjavik is exposed. Many hundreds of kinds of seeds and plants were sent to him from Copenhagen and Christiania. Schierbeck published the results of the experiments in Icelandic as well as Danish periodicals and also had the satisfaction of seeing them appreciated in wide circles. Two years after his arrival he established "The Icelandic Horticultural Society."

[10] Islandsk Urtagards Bok, Copenhagen, 1770.
[11] J. K. Trojels: Om Kartoflens Avl og Brug.
[12] Lachanologica islandica: Maturtabok.
[13] *Landhusholdningsselskabets Skrifter*, Vol. 3, 1794.
[14] N. Mohr: Forsøg til en islandsk Naturhistorie, Copenhagen, 1786.

The work of the Society was supported by the Danish government and parliament. One of the problems he encountered was that of procuring good garden seeds and of placing them in the hands of the consumers so that they could be sown as early in the spring as possible. The raising of Icelandic stocks of cultivated plants was another object. The Society established an experimental garden in Reykjavik.

Horticulture is now supported by 180 local agricultural societies, and agriculture as well as gardening has now several experimental stations at its command. There are given yearly courses in horticulture at the experimental station in Reykjavik. The courses are offered in spring and last six weeks, with both practical and theoretical instruction. The attendance is generally about twenty which, considering the circumstances, is gratifying.

Strictly speaking, market gardening hardly exists in Iceland, for except in the case of experimental stations production and sale are on a limited scale. The vegetable garden naturally predominates; fruit is excluded, and on many farms even a flower garden is lacking. But in the vegetable gardens almost as many different kinds of plants are grown as in Denmark. Sowing in the ground is for the most part unsuccessful. The plants grow too slowly and cannot develop to maturity in the short, uncertain summer. The gardener sows in boxes, pots, and the like, with or without bottom heat, and then plants out later. Potato cultivation advanced and improved greatly during the World War. The Icelandic method of wintering potatoes and other roots has been a model for the Danes.

As has been said, fruit trees do not thrive. Schierbeck and others tried various kinds, but the trees almost always died the following winter. In addition to the old pear tree in Akureyri, there was an apple tree in a garden in Reykjavik; but it remained barren.[15] Of berry fruits only currants ripen regularly, at least in most places. Wild berries grow in many places and are planted now and then in gardens, but the large improved strawberries give ripe berries only in Friland, where they are cultivated in beds surrounded by a frame and covered with glass. In the summer of 1916 a half score pounds of strawberries were raised in the experimental station in Reykjavik.

The Icelandic forest is almost exclusively a birch copse formed of the common birch. Often the trees are mere bushes, but in some places they rise with straight trunks to a height of ten meters. One of the prettiest copses, found at Baejarstadur, has been described many times.[16] Intermingled with this, as in many other Icelandic copses, is the common mountain ash which grows nowhere in pure forest. It reaches the same height and in a favorable situation is able to produce fully ripened fruits. Akureyri was long famous for a large and beautiful mountain ash which, however,

[15] E. Erslev: Om Havedyrkning i nordlige Egne, *Geografisk Tidskrift*, Vol. 1, 1877, pp. 87–95.

[16] Thorvaldur Thoroddsen: Fra det sydøstlige Island, *Geografisk Tidskrift*, Vol. 13, 1895, pp. 3–37. Helgi Jónsson: Vegetationen i Syd-Island, *Botanisk Tidsskrift*, Vol. 27, 1906, pp. 1–82.

was unfortunately lost through a fire in 1902. Several species of willow are found in the birch forests and also as independent copses, and both the native and several imported kinds are frequently planted. The golden osier (*Salix phylicifolia*), which is not found in Denmark, is common and reaches a height of three meters. Beam trees and Swedish service trees do not grow wild but are found here and there in the gardens.

The number of planted trees is small, but various kinds are to be seen in front of the dwellings of garden lovers. The large-leaved elm thrives but grows slowly, the highest example in Reykjavik and in Iceland, a tree of about five meters, stands near the house where taught Iceland's well-known geographer, Thorvaldur Thoroddsen. A Norway maple (*Acer platanoides*) of the same height is also found in Reykjavik, and also a six-meter-high bird cherry (*Prunus padus*). Of deciduous trees with acicular leaves the Siberian larch thrives well. The evergreen tree best adapted to the climate is the mountain pine. It has been planted on Thingvellir Mountain where it reaches a height of about one meter. White spruce and red pine have both been tried but have not spread greatly, the latter at least craving more shelter than is found in Iceland. The ornamental bushes of the garden are all rather modest, and there is found no show of flowers equal to that which adorns the Danish gardens in earlier summer.

The true perennials, just as in Denmark, are the most numerous and conspicuous flowers in the garden. Wild flowering plants have been transplanted in gardens, and in early days those kinds were cultivated that were valuable as medicine or as food. Yet before the monastic gardens reached the north the angelica was cultivated, and other plants like spoonwort, thyme, and rosewort were planted near the houses.

Greenland

The coasts of Greenland are deeply indented with fiords, many of which are filled with glaciers that descend to the sea and produce vast numbers of icebergs. The east coast with its intense glaciation and accumulation of ice drifted by the currents of the north polar basin is a forbidden land. The west coast, although mountainous and glaciated, is more favorable for settlement. The whole interior of Greenland is covered with inland ice which buries the valleys and mountains, leaving only mountain tops, or *nunataks*, visible above its surface. The towns, occupied by the ruling Danish class and the Eskimos, are confined to the immediate coast line. Plant life is also restricted. This is due not only to the cold, which is a limiting factor, but also to the darkness of the winter, which is not counterbalanced by the perpetual day of the short summer. Compared with the area devoted to gardens in the Faeroes and Iceland that of Greenland is of no consequence. Almost without exception the small gardens are confined to the large colonies and are kept up by the resident Danes. In the smaller settlements, as a rule, no gardens are found. The native Greenlanders, the Eskimos, are hunters and fishers. With few exceptions, it is

impossible to arouse in them any appreciation for horticulture; but they do not reject vegetables if offered to them as food. They are very fond of their native angelica, which is found growing wild as far as Disko Island, where it finds its northern limit (about 70° N.). The botanist, M. P. Porsild, who has given an account of the vegetation of Disko Island[17] informs us that the angelica valley behind Ujaragsugsuk from time immemorial has been known far and wide by the Greenlanders, who have been accustomed to make pilgrimages to it from great distances. The angelica grows here 555 meters above the sea in a copse of willows along a brook. Porsild's guide filled his sack with the young, juicy stalks which were peeled and then eaten raw. "One must wonder at the fact," writes Porsild, "that such an apparent, obvious idea as that of sowing seed or moving living plants to more accessible places is still far from the minds of this hunting and nomadic people, that even today this has not occurred to any of them in spite of the close contact with Europeans and in spite of their personal knowledge of European gardening."

In the far north, on the bare rocky plains of Upernivik (latitude 73° N.), gardening is almost impossible. In Friland little more can be grown than radishes, which as faithful, persevering companions follow man farthest in his journey poleward. In a hotbed a gardener who is interested and patient can raise onions, chervil, parsley, lettuce, and other vegetables. Umanak has better conditions. It is a little farther south and lies farther up the fiord, but, as the ice pushes into the inner end of the fiord and lasts long, the gardens are always exposed to danger. Circumstances are similar in the somewhat more southern colony of Jakobshavn, on Disko Bay, and here and at Julianehaab in southern Greenland Pastor Paul Videbaek for many years experimented with gardens. He has described his experience in "The Danish Atlantic Islands,"[18] and this account contains much of general interest. Potatoes can be cultivated at Jakobshavn, but the yield is small and great care is demanded. More fortunate are the conditions in Julianehaab (latitude 61° N.); but the Danish colonists have encountered great difficulties in the way of regular gardening, for the settlement is near the open sea, where plant life meets more difficult conditions than at the upper end of the fiord. When Pastor Videbaek came to Greenland in 1889 very little interest in gardening was exhibited by the colonists. In the span of a half score years, when it had been shown what the garden in Jakobshavn could produce, a greater interest had been awakened.

In the Greenlandic gardens the hotbeds usually take up most of the space. The raised beds are surrounded by steam pipes, and one can produce as much here as in the Danish gardener's hotbed. Kale grows excellently but, like the radishes and turnips, becomes somewhat flat and

[17] M. P. Porsild: Bidrag til en Skildring af Vegetationen paa Øen Disko tilligemed spredte topografiske og zoologiske Iagttagelser, *Meddelelser om Grønland*, Vol. 25, 1902, pp. 91–239; reference on p. 161.

[18] Paul Videbaek: De Danske Atlanterhavsøer.

tasteless. In the autumn the cabbage stalks are made into bundles and are hung in a dry frost-free place and used during the winter. Cauliflower and early dwarf sugar-loaf cabbage grow very well, only the heads do not become as large as they do in Denmark. Rhubarb and small greens like parsley, chervil, and lettuce are grown without difficulty. Pastor Videbaek's garden, which was really a model of its kind, furnished his home with vegetables the year round.

Godthaab, in middle Greenland, is especially known as the field of activity of Hans Egede, Greenland's most famous missionary. In "Old Greenland's Natural History"[19] Egede has given a description of plant life and a few lines about gardening. The pretty grass meadow with the gaudy flowers called for Hans Egede's admiration, but he openly admits that he does not know much about plants. Of course, he knew the angelica. "The angelica plant grows in abundance," he writes, "barley has been tried but does not ripen. Turnips and cabbages grow very well, especially the turnips, which become quite large and of extraordinary good and sweet taste." Potatoes are not mentioned and were evidently unknown in Greenland in Egede's time.

Henrik Rink, scientist and government official (he was the first colonial manager, later inspector of South Greenland), was deeply interested in the economic development of Greenland and did much to encourage the cultivation of vegetables in the southern part of this country. His principal work, "Greenland,"[20] gives an account of the condition of gardening.

The soil of Greenland can be extraordinarily fruitful. It has never been under cultivation and is not impoverished. Pastor Videbaek's garden in Jakobshavn never received manuring but produced year after year an unimpaired, or rather an increased crop. There is always rich manure available in the offal of fish. But there are places where mold is lacking, and a great deal of garden earth has been brought from Denmark and Scotland to the Danish colonies.

In the series of narratives, "From the Greenland That Was,"[21] Mrs. Signe Rink has given a lasting picture of Greenland's colonial gardens during a half century. A low red-painted paling encloses the garden plot, where cabbages, parsley, turnips, radishes—especially the last, "the most excellent vegetable cultivated in Greenland's gardens"—fill the small beds. In earlier times, when life among the Danes in Greenland was simpler than today, turnips were esteemed by every household. Not only the roots but the salted leaves were used as well, mixed with kale. But times have become more refined even in Greenland. The Danes in Greenland, like their kinsfolk in Denmark, now prefer potatoes to turnips. But the cultivation of potatoes presents great difficulties and produces especially in the north a meager harvest. In the extreme south one can expect

[19] Hans Egede: Det gamle Grønlands Perlustration eller Naturale Historie, Copenhagen, 1741.

[20] Henrik Rink: Grønland geographisk og statistisk beskrevet, 2 vols., Copenhagen, 1857. English transl.: Danish Greenland: Its People and Its Products, edited by Robert Brown, London, 1877.

[21] Signe Rink: Fra det Grønland som gik, 1902.

about an eightfold harvest, at Julianehaab only about a sixfold, at Jakobshavn generally only a threefold. All the Danes in Greenland like potatoes, and even the Eskimos value them and in a small way have begun to cultivate them. Cultivation generally proceeds along the following lines. The tubers are planted in pots in March, in May they are planted out in the forcing frames, later the sashes are removed, and in the beginning of September the potatoes can be dug.

One understands what joy it must be for the Danish colonists to succeed in vegetable cultivation in a climate where one would expect them to have to be satisfied with canned goods. They are grateful for dried potatoes, but how much better it is when they can procure fresh ones out of their own gardens! Not much attention is paid to flower gardens. A few asters, nemophilas, mignonettes, and other small summer flowers are about all that are cultivated. Sunflowers have been cultivated in pots at least in Jakobshavn, and the huge blooms cause great amazement among the Greenlanders.

If one wishes to pick a bouquet of field flowers, or rather mountain flowers, it is seldom necessary to go far. The plant life of Greenland can be surprisingly luxuriant. The naturalist Andreas Kornerup has given a lively description of a Greenland forest, or rather copse. Birch and willow bushes formed an almost impenetrable copse at Tumegliarlikfjorden in South Greenland, the mountain slopes were dotted with pastures, the meadows were bright with flowers, and one waded in grass two feet deep.[22] The growth of trees, however, is extremely restricted. It consists of birch copses, such as are described by Kornerup, with a few other kinds: for example willow, green alder (*Alnus ovata*), and American mountain ash. These varieties show that Greenland's plant life is more closely related with that of America than with that of Europe—a now commonly admitted fact, which Professor Eugen Warming, the first thorough investigator of Greenland's plant life, has maintained with great emphasis. The common mountain ash and several species of willow and dwarfish growths belonging to Greenland's flora have found numerous cultivators.

Even where the angelica fails and man has no longer a fixed residence, there are in the northernmost provinces of the polar land fields of flowers. The little trefoil (yellow poppy), *Saxifraga oppositifolia*, and *Silene acaulis* flourish together in the Ice Queen's garden. It is about these three polar plants that Eugen Warming thus expresses himself: "They display an unimpaired vital power up to the most northerly boundaries of life and with certainty could be expected to be found near the North Pole itself, provided that on the whole there were given here conditions for plant life."[23]

If Greenland's Danish colonists take pleasure in their radishes, cabbages, and potatoes, then they also find it in their house plants. From the day

[22] Andreas Kornerup: Om Grønlands Naturforhold, *Meddelelser om Grønland*, 1886.
[23] Eugen Warming: Om Grønlands Vegetation, *Meddelelser om Grønland*, Vol. 12, 1888.

they are sown in boxes or pots until June, when the frames are filled with three to four rows, they are a source of delight. All the summer flowers of Denmark cheer the horticulturist in Friland. Pinks and chrysanthemums, wallflowers and stocks from June until the long polar night fill the rooms with fragrance and color. After the New Year the calla unfolds its white spathe, and the beautiful amaryllis (jacobæan lily) is like a message from the distant tropics. And roses are not lacking, for there are yellow tea roses and pale-red damask roses. Foliage plants—geraniums, aspidistras, begonias, and even palms—are numbered among the potted plants. This is as multifarious and international a company as can be found anywhere. Most of the Danish homes have only a small part of this magnificence, but careful attention has conjured forth something of it in window plants in the coldest inhabited land known to the world.

WORLD WEATHER: A REVIEW*

By Sir Napier Shaw

The author of this work was for many years in charge of Blue Hill Observatory, which was founded, maintained, and directed up to the time of his death by the late Abbott Lawrence Rotch. It is gratifying to find that the activities of an observatory, privately owned and managed, have developed into a survey of world meteorology, because it is to institutions like that of Blue Hill and its associate, the observatory at Trappes near Paris, which was founded and maintained by Rotch's friend, Léon Teisserenc de Bort, that we can look for true freedom of spirit—the best hope of a clue to the intricacies of the world's weather. The two friends jointly organized an expedition to the intertropical Atlantic Ocean for the exploration of the atmosphere over that region. Mr. Clayton was on the staff of the expedition; and, as since that time he has been Forecast Official of the Argentine Meteorological Service, his personal knowledge of meteorological work of all kinds is peculiarly comprehensive. In this book, which is equally comprehensive, he has given the reader the full benefit of his manifold experience. At the outset he treats of daily and yearly periods and later on of other suggestions of periodicity; he discusses at length the relations of weather to the fundamental meteorological elements, also cyclones, anticyclones, sky colors and the physics of the air, radiation, and forecasting.

Tools and Methods

Having recently to form an opinion as to the requirements of productive work in general meteorology, I had arrived at the conclusion that the first need is a library of very special character, with an assistant who knows where to find everything and who is constantly co-ordinating the facts that are known; the second requirement is a well-equipped observatory to keep in touch with atmospheric reality; the third is a physical laboratory with its attendant workshop, in order to explore the possibilities of physical processes that are or may be operative in the free air; the fourth and last is somebody to talk and write about the co-ordinated facts and to think out the mutual relationships of those facts with the physical forces and dynamical laws that observation and experiment have disclosed.

Mr. Clayton's readers will appreciate the reason for regarding a library and co-ordination as the first requisites of scientific meteorology. There are fifteen plates in his book and two hundred and sixty-five figures that

*H. Helm Clayton: World Weather: Including a Discussion of the Influence of Variations of Solar Radiation on the Weather and of the Meteorology of the Sun. xx and 393 pp.; maps, diagrs., ills., index. The Macmillan Co., New York, 1923.

represent facts—myriads of facts—about the weather of the world or incidental thereto such as are to be found only in a good meteorological library, a very rare institution. The speciality of the library, by the way, marks an essential difference between the science of meteorology and the allied astronomical sciences. When astronomers observe the sun or the planets or the stars or the nebulae, they are the same sun, the same planets, the same stars, and the same nebulae for all observers. When the "solar constants" as observed at Mt. Wilson and Calama differ, it is not the sun but the atmosphere that must be regarded as the cause of the difference; for each meteorological observer has only his own piece of atmosphere to work upon, different from that of every other observer. All are parts of one atmosphere, it is true; but no two samples are the same. Every single observation is unique in space as well as in time and can never be repeated. It may be discredited and discarded, but it can never be corrected. Hence, co-ordination of meteorological facts is in itself a problem of no little difficulty. And here we come upon an interesting feature in the progress of meteorology, namely, the line of approach to co-ordination of the facts. A method which has become habitual and almost traditional is to approach them armed with the conception of some particular physical process or some special mathematical formula: we may call it the method of the working hypothesis; and so far does instinct impel criticism that it is hardly an exaggeration to say that in some quarters meteorological observations are regarded as unnecessary unless they are guided by or directed towards the verification of some hypothesis and should not even be undertaken, still less multiplied, except on that basis. To make an experiment in a laboratory without the guidance of a working hypothesis is not science but child's play; and, since the atmosphere is only a physical laboratory on the large scale, the same scientific method is the only one that deserves encouragement.

But there are other minds to whom the process of sallying forth with the law of convection or of radiation or of evaporation and condensation, as illustrated in the laboratory or contained in a neat mathematical formula, to solve the problem of the atmosphere does indeed suggest David going out with his sling and his rounded pebbles from the brook to conquer Philistine ignorance by hitting one of its giants on the head; with this difference, that the giants whose carcasses litter the history of meteorology are not always stuffed with facts but sometimes with somebody's fancies.

Viewing the Atmosphere as a Whole

To such minds it seems that real progress depends upon viewing the atmosphere as a whole, as a general circulation with local disturbances, and that the conception of the whole must be in actual accordance with facts and must not be adjusted to the requirements of a formula; that to spend time producing reasoned explanations of arrangements which do not

satisfy that condition is intellectual lotus-eating, tempting beyond the powers of human resistance, doubtless producing beautiful dreams of the triumphs of mind over matter, but "cutting no ice." Take, for example, the familiar problem of land and sea breezes, such an obvious application of the principle of convection to a limited area and so useful for the school-teacher; how much better off for it is the meteorologist? It is to be feared that the answer is "nothing" unless the motion of the breezes is brought into relation with the general circulation of the air in the whole neighborhood of the locality to which the theory is applied. The question "How does that little region manage to become isolated so as to exhibit the phenomena of convection as though it were a closed space?" is far more vital for meteorology than a description of a process in the free atmosphere on the analogy of what happens in a space with walls and windows, which are unknown in nature where the atmosphere seems to be made up entirely of ceilings. It is now easy to understand that air warmed at the surface will rise until it finds its own potential temperature and then spread out as a layer in this direction and in that; but that, having spread over the sea, it should come down again and recommence its function as cold air wants a good deal of examination before it becomes an explanation.

The whole difference between these aspects of the general meteorological problem may be set out in the question "Shall we approach the solution of our problem by thinking of the forces that are operative, deducing the motion which they must produce and comparing it with observation, or shall we first make out what the motion actually is, in its length and breadth and height, and be led thereby to identify the forces that produce it?" It is a philosophical question, which has an interesting history too long for discussion here.

Yet there can be no doubt that the second alternative is coming to be recognized as the meteorologist's real duty. Mr. Clayton shows by his title "World Weather" that it is in his mind. It is an arduous duty and rather a thankless one, as the dedication of his book indicates; the data are hard to get, hard to find when they have been got, to co-ordinate when they have been found; the gaps are many and vexatious. Some day we are going to have an international encyclopedia of meteorological information with actual working data for the whole world, the product of a complete *réseau mondial;* and the science is going to have its own inductive axioms, its own definitions, and its own analysis. The laboratory and the mathematical textbook are going to be our guardians and our guides though not our jailers. Yet in one lifetime how small is the progress that can be achieved!

> . . . Evermore
> Most weary seem'd the sea, weary the oar,
> Weary the wandering fields of barren foam.

Prominent among the people who have endured the labor that is implied in regarding the world's atmosphere as one and indivisible are Humboldt,

Dove, Buchan, Hann, and Hildebrandsson; but the majority of meteorologists are always tempted to become lotus-eaters.

> . . . Our island home
> Is far beyond the wave; we will no longer roam.

Too many content themselves with the local application of isolated physical and mathematical principles, thereby providing marginal notes for a text which is not yet in existence and which will not be until we can form a real working picture of the circulation of the atmosphere true to all the known facts.

Facts and Forces: Atmospheric Circulation

With the indefatigable workers at the oar of the world's weather Mr. Clayton now associates himself; but he is perhaps not quite whole-hearted in his adherence to the principle of making sure about what one has exactly to explain before embarking upon the explanation. One sign of it is that his first chapter is on the *forces controlling the weather* and not on the *facts which define the weather;* and another is a way he has of interjaculating, as an *obiter dictum*, an explanation of the distribution of pressure as the effect of this or that peculiarity of temperature, as though the causes of distribution were simple. No doubt in co-ordinating facts it is well to have physical and mathematical principles always in mind, and they must be got ready beforehand; but they ought not to be taken for granted from the ordinary experience of the laboratory; they ought to be worked out to open-air conditions so that they may illuminate and not blind the judgment as to facts. How anybody can, for example, put forward the diagrams of atmospheric circulation of Maury (1855), Ferrel (1856), and Thomson (1857) (pp. 41–43) as purporting to represent reality without a sort of feeling of being "accessory after the fact" to a crime against science, I cannot understand. All that one can say about those diagrams is that nobody could possibly sleep in peace if he tried to make them fit in with the distribution of pressure which is shown on page 40 opposite to one of the *pièces de conviction* and is without doubt the most certain co-ordination of our knowledge of the meteorology of the globe. Why, we wonder, is the "circulation" upon a hemispherical projection and the pressure which ought to be correlated therewith on Mercator's projection? One or other of those two representations of the atmosphere must go by the board before a scheme of forces for the atmosphere can be said to accord with facts; and there is no doubt which one it ought to be.

It is, of course, not necessary, nor is it possible to begin straight off with a picture of the circulation of the atmosphere complete in all its details, though Halley and Dampier made better shots than Maury or Thomson. The first draft may quite fairly be a rough sketch; but it is possible and in every way desirable to arrange the outlines so that each additional fact or group of facts for the surface or the upper air, as it comes in, can

find its natural place in the scheme. It is also possible to use our knowledge of physics and dynamics to avoid extrapolations which give impossible results; and it is also good to trust to the sound principle that actual facts are never really in conflict with physical and dynamical laws though they may be in conflict with our ignorance of those laws. Seriously, it is time that a picture of the world's atmosphere in complete zones of uniform flow with as much north or south motion as east or west motion should be understood to refer to Jupiter or Mars, which are some millions of miles away from any possible verification, and not be taken as representing the facts upon which for better or worse the science of meteorology of our own globe must be based.

Such facts as are represented in the diagrams of so-called atmospheric circulation are redolent of the surface, the part of the atmosphere best adapted for showing the peculiarities of the circulation rather than its generalities.

These things are neither mere detail nor unimportant: the future depends upon precision of statement and accuracy of representation. In Chapter 4, for example, Mr. Clayton treats of changes of temperature as waves—hot waves or cold waves. In ordinary language a wave means anything which goes up and down and travels at the same time; but in scientific language wave motion is a special kind of motion in which the form travels but the particles merely oscillate over a small range. Which of these ideas Mr. Clayton has in mind he does not say; but observation can certainly provide an answer to the question.

The "Ascending Current"

Or take another example. Meteorologists in common with other folk are accustomed to bring in an "ascending current" as though it were one of Nature's simplest efforts. Yet most of the evidence which we can get is in favor of the "non-ascending layer" rather than the ascending current, so that the correct description of the normal behavior of warmed air would be that it spreads out in a non-ascending layer as soon as it has found its proper plane. If we think of the observation of a pilot balloon, specially designed to make a rapid ascent, its frequent fate is to get beyond the power of the telescope in, say, ten minutes; and if, instead of hydrogen in a light envelope, we have merely air warmed two or three degrees the column would have to be of incredible length before it formed its cumulus. The ascent of air in the ordinary conditions when cumulus cloud is visible may take fifty miles to accomplish a kilometer of height; and a column of air eighty kilometers long and a kilometer up, at one end, is not what an ordinary person would think of as a column of rising air. Yet the same persons who pass over an ascending current leading to a cumulus cloud as a commonplace event ask us to classify clouds by the process of formation and not merely by appearance.

The Vexed Question of the Cyclone

Another example is afforded by the vexed question of cyclones and anticyclones. How shall we regard a cyclone when it appears upon our map? If we keep constantly in mind the atmosphere as a whole we shall always think of the general circulation as containing a number of cyclones which have an existence for days, sometimes for weeks. "The cause of the progressive movement of cyclones and anticyclones is generally believed to be the general drift of the atmosphere surrounding them at the time. This drift can be inferred with a fair degree of accuracy from the distribution of pressure and temperature in the area surrounding the cyclone" (p. 203). Now this is either true or it is not true. If it is true we shall regard the cyclone newly arrived on a map as a visitor, an existing entity on a journey, and treat it accordingly. We shall not feel it necessary to worry ourselves much about its origin, though we may fairly concern ourselves with the changes which it undergoes in our presence. When a gentleman enters our office we generally ask him his business without endeavoring to explain his origin. We know that in ordinary circumstances he will lose mass and potential energy during his visit; but in some favorable circumstances he may depart refreshed, with his mass and potential energy moderately increased, but still preserving his individuality. If, however, we were imbued with the tendency towards the deductive method, assuming the forces and deducing the motion, our irrepressible instinct on receiving a business visitor would be to explain his origin from the elemental forces, and our business would certainly suffer. We ought not to lose sight of the possibility that during his visit he might be "occluded" and die on our hands, a catastrophe that apparently happens to a good number of aerial visitors to the Norwegian coast. In Norway they "sit upon the ground and tell sad stories of the deaths of kings." But we who live farther west are more apt to tell long stories of royal progresses past our points of vantage. Cyclones that want a long life should be warned to steer for Spitsbergen in preference to Bergen; but most of them have lived long enough to traverse the Atlantic, sometimes diminished and sometimes refreshed and invigorated; and surely it is these that correspond with the typical conditions.

Mr. Clayton is disposed to regard steep gradients of temperature as the immediate cause of cyclones. This explanation is doubtless as good as another. Professor Bjerknes finds the cause in a discontinuity of wind, which is also indicated by a steep gradient of temperature. There need be no hesitation in regarding steep gradients and discontinuities at the surface as of great meteorological importance; but in considering the direct relation of cause and effect one ought, as a general principle, not to expect both the effect and the cause to be prominent at one and the same time; a cause which does not sacrifice itself in producing its effect discredits the proverb that "you cannot eat your cake and have it." It has always

struck me as remarkable about the Bjerknes theory of the cyclone, that he finds the discontinuity, which is the cause, most easily demonstrated in the cyclone, which is regarded as its effect. Some years ago at the London Meteorological Office we were rather closely engaged upon the suggestion of warm air passing over cold water as the cause of sea fog, and we were somewhat astonished to find that when the discontinuity between the temperature of air and sea was most marked there was no fog, and when there was fog the discontinuity was at best very small, until it dawned upon us that if the discontinuity were the cause it must indeed sacrifice itself to produce its effect; that, as the fog was produced by cooling the air, the operation of cooling would diminish the discontinuity. Since that time we have always been shy of seeking conspicuous effects and equally conspicuous causes as likely to occur together. No doubt there are physical effects produced with no sacrifices of cause, such as pressure due to the impact of moving molecules which, according to accepted doctrine, never sacrifice themselves at all; yet if we try the experiment of producing pressure with the jet of a fire hose we find it uses up a good deal of water power. So perhaps we ought to have two classes of the relation of effect to cause and ask for more information; and then in the light of greater knowledge put cyclones in the one class or the other.

Moreover, in considering cause and effect we ought not to pay too much attention to the phenomena observed at the surface to the exclusion of those of the upper air. In a recent paper in the *Quarterly Journal of the Royal Meteorological Society* Kobayasi[1] has shown that one of the chief peculiarities of a cyclone at the surface is a natural consequence of the travel of a symmetrical distribution of pressure, and consequent motion, in the upper air. Hence we are face to face with the question "Is the observed distribution at the surface at any time a cause or an effect?" We may approach the question with calmness in the assurance that, whatever the facts proclaim, theory will be able, sooner or later, to explain; so let us first be sure of our facts, not only for the surface but also for the upper air.

The Sun and the World's Weather

In the latter part of his book Mr. Clayton devotes himself to the study of the sun and its influence upon the weather of the world. In fact the book winds up with a chapter on "The Meteorology of the Sun." The extent and detail of attention paid in Chapter 13 to solar radiation and its application as a method of forecasting for some days in advance give one the impression that it is in the further study of the sun and his radiation that the best hope of progress in terrestrial meteorology is to be looked for; and that impression is certainly based upon undoubted facts. The influence of the sun is, of course, altogether indisputable, and the changes in his radiation as a meteorological element are undeniable; but, as set

[1] Tatuo Kobayasi: On the Mechanism of Cyclones and Anticyclones, *Quart. Journ. Royal Meteorol. Soc.*, Vol. 49, 1923, pp. 177–189.

forth by Mr. Clayton, the subject is afflicted with a certain vagueness, which arises perhaps from the reader's ignorance of a great subject but cannot be dispelled without going below the surface of the book.

It will perhaps be useful to explain this feeling. It is with the variations of the "solar constant" that the meteorological changes are correlated, and the solar constant is understood to be the amount of energy that would be received by a square centimeter of perfectly black surface normal to the solar rays and beyond the confines of the atmosphere. The radiation is measured in gram calories per square centimeter per minute, which is convenient because in that unit the solar constant differs little at any time from 2; but parenthetically we may express the wish that radiation might be expressed in kilowatts per square meter or, for the avoidance of decimals, in kilowatts per square dekameter, chiefly because the use of systematic units is of immense advantage in a science which must ultimately be based on the relationships of physical quantities. This the electricians and magneticians have already abundantly proved; and there are reasons of convenience too. By a happy accident a joule, or watt-second, is a very close approximation to the amount of heat which passes into or out of a gram of air when its temperature changes by a degree (centigrade), and thus radiation and the warming of air are brought into easy relation. Moreover, a kilowatt per square meter, or a hundred kilowatts per square dekameter, is a fair representation of the maximum rate of radiation to be expected in the course of a year at a well-exposed station in the lower levels of the atmosphere. In determining the constant the effect of the atmosphere must be eliminated somehow or other, because the amount absorbed is a large part of the radiation. Hence the solar constant is something which the human eye, or its substitute the bolometer, has never seen and can never hope to see but which the human mind with its amazing ingenuity can calculate.

The calculation amounts to determining, from observations of the energy actually received at different levels, what the total loss of energy is in such favorable positions as Bassour (3600 feet), Mt. Wilson (5800 feet), Mt. Harqua Hala (5600 feet), Calama (7500 feet), Montezuma (9500 feet), Mt. Whitney (14,500 feet) and adding the computed loss to the actual receipt to get the solar constant. The constant so determined is found to vary between 1.90 and 2 gram calories per square centimeter per minute; 1.32 and 1.39 kilowatts per square meter. The variations from day to day are of the order of 2 or 3 per cent of the whole, and on variations of that order Mr. Clayton would have us rely for a substantial part, or indeed the whole, of our changes in weather.

> There is as yet no absolute proof that weather changes would not occur without changes in solar radiation, but my own researches have led me to believe that without these solar changes there would result a balanced system of atmospheric changes such that the same conditions would return year after year at the same time of day and at the same time of year; while the irregular changes known as weather result chiefly, if not entirely, from the irregular changes in solar radiation (p. 282).

There is no vagueness in this statement; the only question is whether the atmospheric conditions on the earth are inherently stable or fluctuating under constant solarization. They are necessarily associated with the transference of vast quantities of water vapor from the equatorial to the polar regions and its return as water, and the circulation has to negotiate some very irregular obstacles in the way of land. Consequent irregularities in the circulation would not be surprising.

The vagueness referred to arises from the fact that Mr. Clayton gives no examples of the actual numerical process of determining the values of the constant, upon the variations of which he would have us rely for the explanation of our weather. No doubt the values have been computed on the methods followed by the experts of the Astrophysical Observatory of the Smithsonian Institution, C. G. Abbot, F. E. Fowle, L. B. Aldrich, and A. F. Moore in succession to Langley, and one cannot think of them as otherwise than accurate; still with meteorologists, who feel themselves attached to the earth in spite of the predominant influence of the sun, there is the remembrance of a note that only 24 per cent of the solar energy survives its passage through the atmosphere and as much as 48 per cent has been lost when 1800 meters have still to be traversed. It is impossible when one is thinking about the weather not to wonder what the two or three quarters of the solar radiation captured by the atmosphere are doing in their captivity. Perhaps they are not captured and have only undergone a process of reflection; but, when one is going to base conclusions on the more or less of two or three per cent, one cannot help feeling uneasy about the atmospheric value of the forty-eight or seventy-six per cent; and unless the process of calculation is deeply impressed upon the mind there is a disposition to think that the complication of a diagram quoted from Mr. W. H. Dines on page 276 cannot be altogether circumvented by throwing oneself on the comparatively minute variations of the solar constant. Mr. Clayton does indeed point out that though minute as a percentage it is vast in its intrinsic magnitude; but, if two per cent is so portentous in its numerical expression, seventy-two per cent would nevertheless be thirty-six times as much. One feels indeed a longing to deal with the solar radiation from the point of view of the geophysicist rather than that of the heliophysicist and to see chrono-isopleth diagrams of the bolometric effect of sunshine, hours one way and months the other, for the various stations where observations of solar radiation are regularly made. And if that is too much to require, then one would like at least a more precise indication of what is added to an observation to give the solar constant. Doubtless, again, all these things are written in the books of the chronicles of the Smithsonian Observatory, but they do not jump to the eye so easily as to make one feel that the information is superfluous in a book on world weather.

Naturally it may occur to the reader to wonder why any one should occupy so many words with remarks upon what might be, and perhaps some-

time or other will be, instead of using them to supply the gaps which in a pioneer work like "World Weather" are inevitable; the simple answer is that, so far as the reviewer knows, the material for filling the gaps is not yet in existence and will take more years than he can look forward to for its completion; and in the meantime let it be admitted that reviewing other men's books instead of making a book according to one's own notions is also a species of lotus eating or indulgence in a mild narcotic that dulls the pangs of hunger for the things that might be and are not and, for a time at least, evokes the pleasurable sensations of a postprandial afternoon.

EARLY TOPOGRAPHICAL MAPS

GEOGRAPHICAL AND HISTORICAL VALUE AS ILLUSTRATED BY THE MAPS OF THE HARRISON COLLECTION

Mr. Francis Burton Harrison, former governor-general of the Philippines, has recently presented to the American Geographical Society a collection of books and maps relating to military events in Europe in the eighteenth and early nineteenth centuries. The purpose of the present paper is to call attention to the historical and geographical value of the 551 maps and, incidentally, to suggest a few of many profitable uses to which the historian or geographer might put almost any similar group of early topographical maps.[1]

Such maps are of twofold interest: for what they actually reveal of topography and human geography, and as illustrations of stages in the evolution of cartography.

Topographical and Human Features Shown on the Maps

Though the fundamental physical features of Europe have remained fairly constant during the last few centuries, the human geography of that continent has been greatly altered. The Industrial Revolution has wrought a profound transformation in the appearance of the earth's surface. New roads, railways, and canals have been built; towns have become enormously enlarged and new settlements have sprung into being; forests have been cleared, valleys converted into reservoirs, and marshes drained.

The historian, particularly the military historian, investigating some earlier period should never rely on modern maps alone, provided he can obtain contemporary maps of his period. He should have both before him, contemporary maps to show the human features *as they were* at the time, the modern maps for a more accurate and graphic representation of the relief.[2]

For the student of human and regional geography, early topographical maps provide a means of tracing the evolution of the various human elements of a district. Economic, political, and social forces operating through different historical epochs have all inscribed their record upon the earth's surface. The cultural features, therefore, which appear upon a modern map are an elaborate complex of the old and the new. Two roads are

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[1] The maps of the Harrison collection are discussed in greater detail in a booklet of similar title to this paper pending publication by the American Geographical Society. In the booklet (which will be supplied to Fellows of the Society gratis upon application) the suggestions made in the present article are developed more fully.

[2] The fact, therefore, that the Harrison collection is housed in the building of the American Geographical Society where students may make use of the Society's extensive files of modern maps adds materially to its practical value for purposes of research.

represented, each shown by the same symbol. One is an eighteenth century highway: its neighbor was built but yesterday to a newly opened mine. How are you to tell the difference? A series of old maps should help us answer this question by giving a short cut to a chronological analysis. By means of early maps we may segregate many of the composite elements of a region according to their approximate dates. If, in addition, we know something of the history of the region, the maps should go far towards enabling us to interpret directly the facts of present-day geography in the light of the historical events and movements which have produced these facts. And no study in human geography is worthy of the name which ignores the historical factor.

As a simple illustration, compare Dortmund as shown on a map in the Harrison collection dating from 1805[3] and as shown upon the Prussian Landesaufnahme map of 1901[4] (Figs. 1 and 2). On the earlier map the town appears as a small, oval, medieval city without suburbs. The later survey shows the nucleus of the old walled town still clearly in evidence, but it has been surrounded by the larger city of modern times. The built-up parts of neighboring villages have grown, and some have become suburbs of the city. Canals, railways, and new roads are everywhere apparent. In the northern part of the map an entirely new village, Königsheide, with rectangular streets, has emerged upon country that the earlier map represents as heath. These are the facts presented by the maps. For the explanation of these facts, we must look to the history of a century of industrial growth in the Ruhr valley: for the explanation of Königsheide, perhaps, to the town-planning movement of the nineteenth century.

Figure 5 shows a series of cartograms of Brussels and its vicinity all drawn to the same scale from early and recent maps in the possession of the American Geographical Society.[5] These display vividly the story of Brussels' material growth from the sixteenth to the twentieth century. Even if we have no knowledge of the detailed history of Brussels, much may be inferred from these cartograms in explanation of its present urban geography. The positions of certain of the narrower streets of the city were obviously determined by the position of the inner circle of fortifications shown in the

[3] Section 15 of Von Le Coq's map of Westphalia. Approximately 1:85,000.

[4] Sheet 335, 1:100,000.

[5] In Figure 5 the cartograms were drawn from the following sources: "Ca. 1550" from Jacques de Deventer's plan of the city (scale approx. 1:8650) as reproduced in "Atlas des villes de la Belgique au xvi[e] siècle. Cent plans du géographe Jacques de Deventer executés sur les ordres de Charles Quint et de Philippe II," livr. 9, Brussels, Institut National de Géographie, no date. "Ca. 1670" from an undated plan (scale approx. 1:6000) by F. de Wit in an atlas of maps and plans with engraved title page bearing the inscriptions "Atlas. Amstelodami ex officina Jac.[i] de la Feuille. Cum Privilegio Ordinum Hollandiae et Westfrisiae. P. Harrewyn inv: et fecit 1685." De Wit produced many maps and plans during the latter part of the seventeenth and early years of the eighteenth centuries. "1777" from "Plan Topographique de la Ville de Bruxelles et des ses Environs. . . . Gravée par L. A. Dupuis Géographe en 1777" (scale approx. 1:5000) forming plate XXI of "Carte Chorographique des Pays-Bas Autrichiennes . . . Par le Comte de Ferraris." "Ca. 1860" and "ca. 1871" from undated plans (scale approx. 1:14,500) in Bradshaw's "Continental Railway Guide" of about the period. The changes shown in the plan "ca. 1871" were made between 1867 and 1871. "1890" from map of "Bruxelles et ses Environs" (1:40,000) of the Institut Cartographique Militaire.

The built-up areas as shown on all the cartograms have been deduced from the maps and plans upon which the cartograms were based and cannot, of course, be regarded as altogether accurate in detail.

Fig. 1

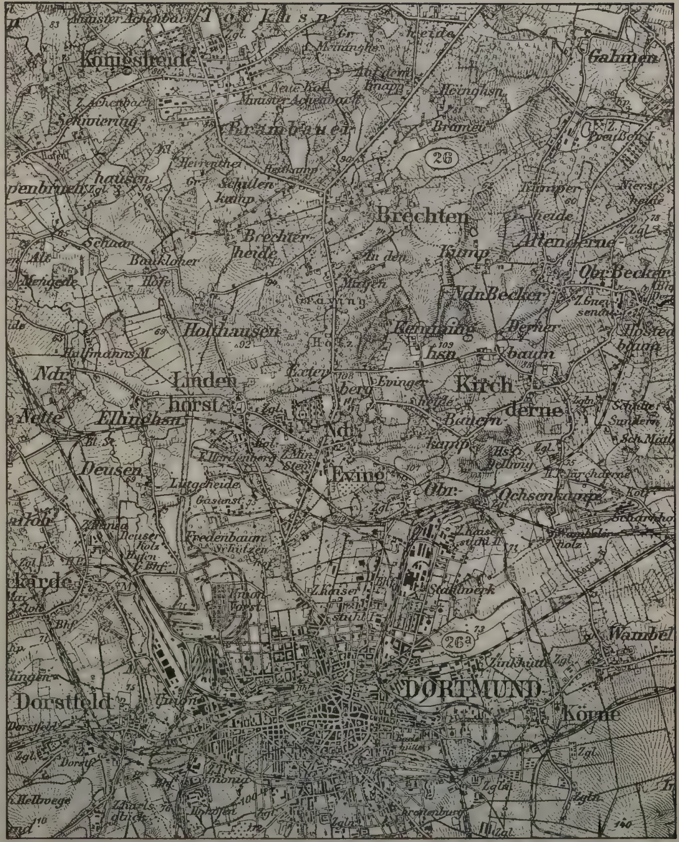

Fig. 2

Figs. 1 and 2—The vicinity of Dortmund in the Ruhr region as shown upon maps of 1805 and of 1901 reproduced on the same scale.

FIG. 3

FIG. 4

FIGS. 3 and 4—The graphic but inexact representation of relief in the Erz Mountains as shown on a map of 1714–1720 (Fig. 3) contrasts with the careful hachuring of the hills south of Ulm as shown on a map of 1818 (Fig. 4).

cartogram of 1550–1565: the encircling boulevards, as in Paris, replaced the outer ring of fortifications. The Industrial Revolution and the creation of Brussels as capital of an independent Belgium brought an increase in population in the nineteenth century, shown on the maps by a wide expansion of the built-up areas in all directions far beyond the boulevards.

Illustrations of the Evolution of Cartography

The evolution of cartography has been a long and complicated process. Though many studies in its history have been published, the spirit animating most of their authors has been that of the collector or "cartobibliographer." Regarded broadly, the history of cartography as an art and science is still largely a virgin field. The maps of an age depict its intellectual character almost as faithfully as painting and sculpture reflect its imaginative and artistic impulses.

The maps of the Harrison collection serve admirably to illustrate many aspects of the history of European cartography: on the one hand, the close relation between map making and movements in the political, military, and scientific spheres; on the other, technical advances in the field and drafting room.

Two forces were mainly responsible for the improvement of the cartographic art in the period represented by these maps: advance in the realm of pure science, and advance in the art of war. The need of maps of a large scale for peace-time economic purposes seems to have been of secondary importance until the nineteenth century was well under way.

Throughout the seventeenth and early eighteenth centuries the scientific world had been deeply occupied with the problem of determining the size and shape of the earth. The origins of modern topographical methods may be attributed, in part at least, to methods developed in the course of investigations leading toward the solution of this problem. Triangulation as a foundation for map making had been suggested early in the sixteenth century.[6] The earliest triangulations of large tracts were carried through for the purpose of measuring arcs of meridian, and it was an easy step from the use of trigonometric surveys for this purpose to their application to cartographic ends. The first great map of a European country based upon triangulation was Cassini de Thury's "Carte de France," surveyed, engraved, and published between 1747 and 1793. The influence of the Cassini map was very great; indirectly it inspired the inauguration of similar surveys in other parts of Europe; directly it was amplified and corrected by various maps based upon or in extension of it. The results of its influence are well shown in many items of the Harrison collection.

If pure science contributed to the trigonometrical accuracy of maps, war, more than any other force, demanded their production in quantity and necessitated their improvement in the representation of the details of the

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[6] See the *Geogr. Rev.*, Vol. 13, 1923, pp. 325–326.

FIG. 5—Brussels 1550–1890. Fine single lines indicate streets which have been continuously in existence since 1550. Double lines represent important streets and boulevards of subsequent date. Heavy single lines are fortifications. Dotted lines are the routes of former fortifications. Fine single lines parallel to dotted lines are boulevards following the line of demolished fortifications. Heavy cross-hatched lines are railroads. Shading indicates built-up areas. Isolated houses in the country are shown only on the cartogram "ca. 1550." For sources see footnote 5.

earth's surface, particularly of relief. With the wars of the French Revolution and Napoleon, the formal tactics of the preceding epoch, when bodies of troops in close order were maneuvered about each other like chessmen, gave way to more individualistic tactics. Greater initiative was expected of the leaders of small units and of the private soldier. In place of refined, geometric conceptions was substituted a closer adaptation of the tactics of each particular engagement to the particular conditions prevailing—conditions determined by the numbers and equipment of the troops, by their morale and leadership, and especially by the terrain. More precise and powerful small arms and artillery added urgency to the need of an accurate understanding of terrain, particularly in the matter of cover, and this expressed itself in a demand for better topographical maps and especially in a demand for maps showing relief with greater realism. Moreover, quite apart from tactical considerations, as armies grew in size at the time of Napoleon and as campaigns were pushed ever farther afield, the requirements of troop movement and transport could only be satisfied by better maps. It is altogether natural, therefore, that the best maps of the first decades of the nineteenth century were produced by the French *Dépôt de la Guerre* and by army officers of the various German states.

Many of the more important of these maps are included in the Harrison collection, and they serve admirably to illustrate the rapid improvements of cartographic technique in a large variety of ways which we cannot pause here to discuss. Suffice it to call attention to Figures 3 and 4, which show side by side a portion of the oldest and most archaic map of the Harrison collection, Müller's "Bohemia" dating from 1714–1720, and a portion of the beautiful *Dépôt de la Guerre* map of Swabia, dating from a century later (1818). A glance at the crude, medieval relief of Müller in contrast with the concisely executed hachuring of the *Dépôt* map, will serve better than many pages of explanation to reveal the extraordinary technical advance that took place during this critical century of cartographic development.

CAPTAIN JOHN SMITH'S MAP OF VIRGINIA, 1612

By Worthington Chauncey Ford

This is frankly a little journey into the realm of hypothesis regarding the actual maker of the map of Virginia that Captain John Smith put forth in 1612.

Earlier Maps of Virginia

Four years earlier Smith's name had been associated with "A trve Relation of such occurrences and accidents of noate as hath hapned in Virginia since the first planting of that Collony, . . . London, Printed for John Tappe, and are to be solde at the Grey-hound in Paules-Church yard, by W. W. 1608." This tract was issued with three variant title pages, and Smith was the author. The tract was written after Smith and Newport had explored the James (Powhatan) and Chickahominy Rivers and after Smith had been carried by his Indian captors across country to the Mattapament (which he made a branch of the James), the Topahanocke, the Payankatank and finally to Waranacomoco, where the Indian chief resided. No suggestion is contained in the tract of a map, either intended or in process of making, though this is not necessarily conclusive on the point, as the seventeenth century editor, "I. H.," admits that "somewhat more was by him [Smith] written, which being as I thought (fit to be private) I would not adventure to make it publicke." In the jealousies then existing among nations on plantations in America the suppression of a map might be defensible—even expedient. The main point, however, is that by 1608 explorations had been made and all the names of Indian towns in the "True Relation" appear on the Smith map of 1612 and very much as his text located them.

No aid from others is admitted in the "True Relation," and it is the same in Smith's tract entitled "A Map of Virginia" (Oxford, 1612). Captain Smith stands sole sponsor for the writings. Between 1608 and 1612 the material for the Smith map was prepared. It is known that Robert Tyndall of the plantation, who had been in the exploring party with Newport, was competent to make a map. An example of his work is "The Draughte of Virginia . . . 1608," which Brown believes was sent to England in 1608 with Newport's journal.[1] An even earlier map of the James prepared by Tyndall and sent to Prince Henry in 1607 is lost, but it could hardly have contained features other than are in his "Draughte" of 1608.[2] Then there is the chart of unknown authorship, of which Zuñiga sent a copy in September, 1608, to his master, Philip III, and which was found in the

[1] Reproduced in Alexander Brown: The Genesis of the United States (2 vols., Boston, 1891), Vol. 1, facing p. 150.

[2] *Ibid.*, Vol. 1, p. 109.

FIG. 1—John Smith's map of Virginia. Dimensions of original 12½ x 16 in.

This reproduction is from the ninth or tenth state of the map (see p. 438).

archives of Simancas.[3] The Zuñiga chart is a copy, Brown asserts, of the map sent from Virginia in 1608 with Smith's "True Relation" and with intention of making it public with that work. The original of the copy sent by Zuñiga was prepared before Smith had fully explored Chesapeake Bay. Fairly correct to the Tappahanock, the Zuñiga copy shows that Smith was hopelessly adrift in the Potomac regions, where he makes a great stream sweeping to the north. What gives this feature peculiar interest lies in the interpretation of it Smith conveyed to Henry Hudson. The Verrazano myth of a great sea, the "Mare Indicum," from which the Atlantic was separated at Virginia by a strip of land of a few miles, had been embodied in maps and still persisted to awaken and color the hopes of those in search of a northwest passage. Smith had sent letters and sketch maps from Virginia to Hudson, informing him of a sea lying to the north of the southern English colony and leading into the western ocean.[4] Acting on this suggestion Hudson sailed for the fortieth degree and found the river which bears his name.[5]

Next in order of time is the map prepared in 1610 for James I, known only by a copy sent in 1611 to Philip III, King of Spain, by the Spanish ambassador in London, Velasco.[6] Although there is a difference of only two years between the Tyndall draft and the Spanish sketch of 1608, on the one hand, and the Velasco map of 1610, on the other, a great advance in knowledge of the bay and rivers is shown on the latter. No one can for a moment believe that Velasco's copyist based his Virginia upon the earlier charts; and the marked, somewhat exaggerated, bend in the Potomac River is that which appeared in the Smith map of 1612 and became a test for determining how far atlas makers incorporated the features of Smith's map. Tyndall had given "King James his River" and "Prince Henneri his River" (the Pamunky); beyond those no rivers were named, nor was the course of any other river so much as suggested in a manner to make

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[3] *Ibid.*, Vol. 1, p. 183. The reproduction, *ibid.*, facing p. 184, is unfortunately a tracing from a "copy," and no judgment can be formed as to how far it omitted or imitated the tricks of the original, so useful and necessary in identifying writing and workmanship. The "copy" appears, however, to have been made by an Englishman.

[4] Hudson took the Smith maps and notes to Holland. Samuel Purchas, Hakluytus Posthumus or Purchas His Pilgrims, London, 1625, Vol. 3, p. 590 (reprint, published by James MacLehose & Sons, Glasgow (20 vols., 1905–1907), Vol. 13, p. 359), against the account of Hudson's voyage of 1609 has the reference, "This agreeth with Robert Tyndall." Hudson also speaks of the "Barre of Virginia" at the entrance of "the Kings River," suggesting the sketch map of 1607 or 1608, with "King James his river." He sailed from England on his third voyage March 25, 1609.

[5] The Virginia legend of a western sea persisted certainly to 1621. For Parkinson then reported finding a "china box" or casket in the house of the King of Potomac, "lined in the inside with blue Taffata after the China or East India fashion. They enquiring whence it came the King of Patomecke said, it was presented to him by a certaine people of the Mountaines toward the South-west, who got it from another Nation beyond them some thirtie dayes journie from Patomacke, called Acana Echinae." It may be suspected that Parkinson in writing the spoken word gave it a form suited to his wish, for Echinae too closely reflects his China of the box. But the "continuall constant relations of all those Savages in Virginia, of a Sea, and the way to it West," to which one of the Virginia rivers would give a "safe, easie, and good passage to the South Sea, part by water, and part by Land, esteeming it not above an hundred and fiftie miles from the head of the Falls, where we are now planted," encouraged a hope of "a most rich Trade to Cathay, China, Japan, and those other of the East Indies, to the inestimable benefit of this Kingdome." Purchas, *op. cit.*, Vol. 4, p. 1786 (Glasgow edit., Vol. 19, p. 152).

[6] As reproduced in Brown, *op. cit.*, Vol. 1, facing p. 456, a tracing of a copy of an original.

identification possible. The Velasco map has the King's River, the Prince's River, the Queen's River, and Elizabeth River and carries Chesapeake Bay to its end into an unnamed river. It was made at a time when patriotic feeling and courtly policy gave names intended to flatter and win favor.[7] The courses of the four rivers, even to the branches, are those of the Smith map of 1612; and the islands in shape and location answer to those on Smith. The Indian names of places also correspond, due allowance being made for the vagaries of the engraver.[8] To the west Velasco gives nothing that is not to be found on Smith, and his outlying points are those of Smith. It is evident that Velasco saw an early, perhaps the first, draft of Smith's map before the royal names of rivers had given way to the original Indian names. He sends this copy to his master as a map of Virginia. Any map of the American continent of 1611 would have given the far-flung line of French America, but none save Smith's would have given Virginia in such detail.

The Map Attributed to Smith

We now come to the map which passes under Smith's name, an elaborate and detailed production of the highest historical importance and worthy to stand as a fine example of map making for that time. It embodies the results of a number of surveys, but it is hardly possible that an English draftsman drew the original plan. Were he depending upon a number of sketch plans he would be liable to go astray in piecing them together and to commit grave indiscretions—or worse—in filling in the gaps. There is nothing to show such patchwork; and the draft or plan from which he worked must have been consistent and quite complete in the broad generalizations, leaving to his imagination or practical experience the filling in of the vacant places with suggested or conventional features.

The Smith map was first published in 1612 in connection with the tract "A Map of Virginia," which was written by Smith and to which was appended Symonds' "Proceedings," based upon accounts from Virginia. Among these accounts one from Nathaniel Powell is named. Smith's portion of the tract is at once an encouragement to would-be settlers in the new plantation and a reply to slanderous reports of the land that were being spread by "some bad natures . . . that will slovenly spit at all things, especially in company where they can find none to contradict them."[9] The mention of the map in the tract makes no claim to authorship, nor does

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[7] Cf. Hudson's three capes, 1610: Prince Henries Cape, King James his Cape, and Queene Annes Cape. Purchas, *op. cit.*, Vol. 3, p. 599 (Glasgow edit., Vol. 13, p. 382).

[8] This is shown by the places noted on the James River beginning at its mouth, as follows, the first version being according to Velasco, the second according to Smith: Checepiock, Chesapeack; Mattanock, Mattanack; Ile of Hogkes, Hog Ile; Quayonghoohanck, Quiyonghcohanock; Appamatusk, Appamatuck; Massinacach, Massmacack; Monahassanugh, Monahassanugh; Rossawick, Rassawick. Near the end of Chesapeake Bay Velasco has Tacough river, Smith has Tochwogh flu.

[9] "A Map of Virginia," p. 37.

it suggest any immediate agency in its preparation.[10] On the first issue of the map itself the words "Discouered and Discribed by Captayn John Smith" and "Grauen by William Hole"[11] are found under the scale; but in the second issue, or state, the year 1606 has been inserted under the word "Smith."[12] In that form the legend continued unchanged in the nine states following the first, for ten different states have been described.

As engraved, the Smith map shows an advance upon the Zuñiga chart. The Potomac has been explored and properly empties into Chesapeake Bay, and the Bay is carried on to the Susquehannah. Thus was eliminated Smith's pardonable error in believing that in or near Virginia could be found a passage into the western ocean. The last state of the map from the Hole plate was made in 1632; and the alterations and additions between 1612 and 1632, chiefly in place names, were neither numerous nor important. The lines were so fixed that it is easy to recognize the map, even when masquerading in odd forms adopted by other map makers. It was the most authoritative survey of the country yet furnished and had no real predecessor.

The merits of Smith's map were recognized by the best map makers of the Netherlands, but time was required to absorb them and make the new plates. Only in 1628 was there inserted in Mercator's atlas a map—"Nova Virginiae tabvla"—which is the Smith map engraved by a Dutch engraver. Thus sixteen years passed before any trace of Smith is found in the best atlases of the day; then his map was taken bodily, without change.

De Laet in 1630 issued an excellent map of the coast from Nova Scotia to Cape Fear, evidently based upon Smith for Virginia, possibly on Smith for New England, and certainly on the Dutch map for New Netherland. In Mercator of 1631 is the map of America redrawn—"Auct. Henrico Hondio, 1631"—with an inset showing Brazilians omitted and the outline of North America materially changed; but it was not until 1638 that the "America Septentrionalis" gave the coast in approximately its final form. As a Mercator-Hondius atlas, 1636 (Hexham's translation), it gives the Smith map, the earlier "Virginiae Item et Floridae Americae Provinciarum, nova Descriptio," which had first appeared in 1607 and was based upon Bry, and a third map—"Nova Anglia Novvm Belgium et Virginia, Johannes Janssonius, excudit"—which is the De Laet map re-engraved on a larger scale, with additional names of localities to the

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[10] *Ibid.*, p. 10. William Strachey wrote his "History of Travaile" about 1616–1618 and noted in the margin "A dew remembrance of Capt. Smyth, vide lib. iii, cap." but never got beyond his second book. Against that marginal note are the words: "their severall habitations are more plainly described by the annexed mappe, set forth by Captain Smith, of whose paines," etc. The lithograph of the map in the Hakluyt Society's issue of the "Historie of Travaile," *Hakluyt Soc. Publs.*, 1st Series, Vol. 6, London, 1849, facing p. 23, is misleading, as it omits the "inset" illustrations, the very feature mentioned by Strachey. Mr. Eames gives the true explanation, that the person making a tracing of the map gave up when he came to the illustrations.

[11] William Hole was one of the earliest of English engravers. Portraits, title pages, and music (he was the first in England to engrave music on copper plates) gave him occupation, but his work is not held in much estimation by collectors.

[12] See below, p. 443, footnote 24.

north. No change occurs in the region of Virginia. After 1630, then, though Smith's map had been fully adopted by the atlas makers, the earlier charts were still retained in the atlases.

No definite claim appears to have been made by any of Smith's contemporaries that the map was actually the work of his hands. It was not known as the work of Smith any more than the early map of Florida was known as the Chiaves map. In each case the plot was associated with the name of the person who had described the region plotted. De Laet, who first published his work in 1625, in the section devoted to Virginia refers to the representation of an Indian on Smith's map, but he does not give Smith's name in connection with it, nor has he a map of Virginia in his volume. Such a map makes its first appearance in the issue of 1630 of De Laet, and it is based upon Smith. In the text De Laet reproduces the Indian figure, but there is still no mention of Smith by name. A Latin translation was printed in 1633, and here Smith does receive credit by name. "Iconem unius barbari Joannes Smithus in tabula sua Geographica nobis expressit, quam hic adjungere operae precium putavi" (p. 79). The French version of 1640 (p. 86) is to the same effect.

Further, no one has claimed or shown that Smith could make a map of quality; he furnished material while employing or directing others to do the actual drafting. The only known example of his ability to draw a plan is the sketch map of the coast of Virginia sent to Lord Bacon in 1618, six years after the elaborate map of Virginia had been engraved by Hole and published. It is inept and almost childish.[13] As not a little depended upon the issue of Smith's application to Bacon, it is somewhat strange that he should have submitted so crude a drawing when the engraved map was to be had.

Some support of this estimate of Smith's ability to draw a map is to be found in the so-called Smith map of New England, which first appeared in 1616, engraved by Simon Van de Pass, who came to England in that year. Compared with the map of Virginia that of New England was simplicity itself, for it is confined to the coast line; and whatever features in the two maps seem alike can be explained by the conventions of map engraving then accepted. Van de Pass was no novice in the art when he made the Smith plate. On the New England map the legend reads "Observed and described by Captayn John Smith." Here again the actual making of the map, that is, the plat form from which the plate was made, is not assigned to Smith's hand.

Powell as the Maker of the Smith Map

The companies which obtained grants in America were anxious to colonize and to receive some returns. One of the first objects was to explore the land and describe its fitness for habitation—the special features which would

[13] Reproduced in Brown, *op. cit.*, Vol. 2, facing p. 596 (second map).

appeal to the adventurer. Surveyors went out in the first ships, and at Jamestown Tyndall was not the only surveyor or map maker. The name of another, Nathaniel Powell, carries weight, though nothing from his hand has been identified. He sailed to Virginia in the spring of 1607 and accompanied Newport in his expedition up the James River. For six weeks in the autumn of 1608 he explored Chesapeake Bay with Captain Smith. He was thus qualified to draw a map of the river and bay. In the absence of any product of his pen, is there any evidence of his work to be found in the printed records? Brown[14] states that a map by Captain Powell of Chesapeake Bay and its rivers was that "probably" sent by Captain John Smith in December, 1608, to accompany "The Relation of the Countries and Nations" printed in the same year as "A True Relation." No proof exists on this point.

In 1641 there appeared in London a tract of four leaves entitled: "A Direction for Adventurers With small stock to get two for one, and good land freely:" etc.,[15] one of the frankly advertising tracts of the period. It was written to a member of the Plowden family by Robert Evelyn, then in Virginia. In this tract, or letter, Evelyn said: "But going to *Delaware Bay*, by Cape May, which is 24 miles at most, and is as I understand very well set out, and printed in Captain *Powels* Map of *New England*, done as is told mee by a draught I gave to M. *Daniel* the plot-maker, which Sir *Edmund* [Plowden] saith you have at home," etc. I have not identified any map maker of that time of the name Daniel.

In 1648 Evelyn's letter was incorporated in Beauchamp Plantagenet's "A Description of New Albion." The name Beauchamp Plantagenet is suspiciously romantic, but the tract has some merit. In its third chapter Powell's map is again mentioned and in connection with certain well-known printed works: "Which is further witnessed by Captain *Smith* and other books of *Virginia* and by *New Englands* Prospect, new *Canaan*, Captain *Powels* Map, and other descriptions of *New England* and *Virginia*." This sentence forms part of a certificate, apparently drawn before 1641, signed by Evelyn and twelve others endorsing the book as a "true state of the Country, of the Land, and *Delaware Bay* or Charles *River*." Smith's "Virginia" appeared in various issues from 1624 to 1632; Wood's "New Englands Prospect" was printed three times between 1634 and 1639; Thomas Morton's "New English Canaan" was published as from Amsterdam in 1637. All the works named by Evelyn have been identified except the map of Powell. It is stated that at the time the certificate was prepared Evelyn had been "4 years there," and Evelyn went out in 1634. He was therefore no stranger to America.

In one respect Evelyn's statement is confusing, for he speaks of Powell's map of New England. This was a not improbable slip of the pen or con-

[14] *Op. cit.*, Vol. 2, p. 971.

[15] Only two copies of this tract have been located, one in the British Museum and another in the Henry E. Huntington Library, to whose courtesy I am indebted for a photostat copy.

fusion of memory, for in the early seventeenth century the names Virginia and New England were loosely used. No reason can be given for mentioning a map of New England to confirm the outlines of Delaware Bay or the Charles River. No evidence is available to show that Powell was ever in New England, and his prominence in Virginia would preclude a wandering life. He was killed in the massacre of 1622. Evelyn may have meant Smith's map of New England, but it is not likely. For that map was published some time after Smith had left Virginia and when he was not on very good terms with the Virginia Company and its plantation. Taking the double mention of Powell's map as of something quite accessible in print and knowing no other map of Virginia engraved and in print but that which passed as Smith's, I am inclined to advance the claim that Powell, a skilled surveyor, made the plat form, or basis, of the Smith map and is entitled to the credit of it.

Robert Evelyn

Who was Robert Evelyn, on whose uncertain sentences this theory is founded? In April, 1634, Captain Thomas Young, intent upon making new discoveries in America, applied to Secretary Windebank for a royal patent, setting forth that the king had employed him (Young) and his nephew Robert Evelyn in America "upon special and weighty occasions of his Majesty's own particular service, which his Majesty thinks fit should remain private to himself;" with power to leave the king's dominions without any questions. The governors of all colonies in America, particularly of Virginia, were to be instructed "to afford them every assistance, with liberty to traffic in those parts." He proposed also to take with him, as his cosmographer, Alexander Baker, "skilful in mines and trying of metals, at liberty on bond, in regard of some matters on conscience," and another person, Scott by name, as his physician. Knowing the unruly character of seamen of the time he further asked that "some of his principal seamen may be called before a person of authority and charged strictly to obey Capt. Yong and his nephew." He insisted that the articles should be kept "from being seen or known by any."[16] The patent itself echoed so far as it was able these somewhat mysterious and unlimited powers. It stated that the king had been pleased to employ the two men in America, "upon speciall and weighty affaires concerning our private service, whereof we expect a speedy accompt from them. We doe therefore hereby streightly charge and command you and every of you to permitt and suffer the said Capt. Thomas Young, and Robert Evelyn, and theire Company freely to passe and goe, and depart out of anie of our Dominions aforesaid about this our service without any your questions, stoppes, letts, Molestations, pressing interruptions or hindrances in any kind whatsoever. And we do further will and require you and every of

[16] W. N. Sainsbury, edit.: Calendar of State Papers, Colonial Series, 1574–1660, London, 1860, p. 177.

you to give them your best furtherance, ayde and assistance from time to time in theire necessary occasions when and as often as they shall require the same. And hereof you are not [to] faile as you will answere the Contrary at your perills."[17] With such powers Young could have indulged in piracy and claimed the royal protection.

Young must have sailed shortly after receiving his "patent," for on July 3 he arrived in Virginia. Here he attempted to engage a ship carpenter of another vessel, without the consent of the master, which led to an outburst of temper on the part of Captain Matthews, a Virginia magistrate, who said that Young's commission "had not been shewn to him and he knew not whether Yong had any commission or no, and that if things were done in this fashion it would breed ill blood in Va., and so flung away from the Governor in a contemptious and proud manner and turning his back with his truncheon lashed off the heads of certain high weeds that were growing there."[18] All of which was embodied in a statement signed by Young and Evelyn, as well as by Thomas Cornwallis and Thomas Purify, who were present at the altercation. Young built two shallops and about July 25 went upon his voyage of discovery. Nothing more is known of him.

Some six months later we find Lieutenant Evelyn receiving a letter from Governor Harvey of Virginia, to be delivered in person to Windebank,[19] indicating that he was on his way to England. Nothing further is known of him until about January, 1637, when he was appointed surveyor of Virginia in place of Gabriel Hawley deceased, and also a member of the Council. It was stipulated that he was to continue to enjoy the favors granted to him by the king's letters of April 18, 1634.[20] He again went to England in 1640, where his pamphlet or letter we have quoted was printed; but he had already become a resident of Maryland and was commander of Kent Isle and a member of the Assembly of that colony in 1637–1638 and in 1642.[21]

Conclusion

Although grave doubts and suspicions may be awakened by Beauchamp Plantagenet's somewhat stagey name and rambling book, the person and letter of Evelyn are authentic. He was familiar with Virginia and had succeeded to its surveyor's office, with its possible records of what had been done by his predecessors. He speaks of Powell's map as in print and with no such emphasis as would indicate that the map was more difficult of access than the publications he named with it. Perhaps there was a recognized tradition in Virginia that Powell did make the map of 1612; and memory of origin would be more likely to persist in

[17] Helen Evelyn: History of the Evelyn Family, With a Special Memoir of William John Evelyn, M.P., London, 1915, p. 533. The patent was dated April 18, 1634.

[18] *Virginia Mag. of History and Biography*, Vol. 8, 1900–01, pp. 156–157.

[19] *Ibid.*, p. 161.

[20] Sainsbury *op. cit.*, p. 244.

[21] *Virginia Mag. of History and Biography*, Vol. 9, 1901–02, p. 172, note.

the colony than in England. Certainly if the Smith map held a supremacy in Europe for thirty years, it must have done so because no better map had been made, and the existence of a better map would have been known in Virginia by its official surveyor. We have evidence that as late as 1659 the Smith map was regarded as authoritative. In that year, when the Dutch representative, Herrman, came to Maryland, Secretary Calvert showed him some maps of Virginia: "two that were engraved and one in manuscript. One was printed at Amsterdam, by direction of Captain Smith, the first discoverer of the great bay of Chesapeack, or Virginia; the second appeared also to be printed at Amsterdam, at the time of Lord Balthamoer's patent; we knew not by whom or where the manuscript one was drawn. All differed, one from the other."[22] Again is curiosity excited by the statement that a map of Virginia was printed in Holland "by direction of Captain Smith." No such map is known, though the Hole plate may have been sent to Holland; or Herrman may have seen a Smith map as it was printed for a Dutch atlas, the name of engraver or printer being upon it; or, finally, "direction" may have been intended for "description," a word on the Smith map. The Cecil map is in "A Relation of Maryland," 1635, labeled "Noua Terrae—Mariae tabula," intended to show the northern part of Virginia "for the better description of the entrance into the Bay of Chesapeack." It is frankly based on Smith's map, but English names of localities predominate in the region covered by the grant to Lord Baltimore. The engraver, Thomas Cecil, best known for his portraits, was in estimation at the time, and he "has the credit, rare in artists of his period, of being an Englishman."[23] Herrman's statement is a bit of evidence that to 1659 no map of Virginia had been published that would take the place of Smith's as a better representation, and 1659 was eleven years after the year of Plantagenet's tract on New Albion. Herrman knew a map, for he could make one (he prepared a map of Maryland and Virginia, published in 1670).[24]

Slight as the evidence is, it serves in my opinion as a suggestion, and I believe that a question may be raised on the actual maker of the map that has passed under Smith's name. I make the suggestion in the hope that it may lead to investigation by others.

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[22] Augustine Herrman: Journal of the Dutch Embassy of Maryland, 1659, in C. C. Hall, edit.: Narratives of Early Maryland, 1633–1684 (Original Narratives of Early American History), New York, 1910, pp. 314–333; reference on pp. 323–324.

[23] Dictionary of National Biography, Vol. 9, p. 405.

[24] As late as 1735 the map attributed to Captain John Smith was used as one of the sources of "A Map of Virginia according to Captain Iohn Smiths Map Published Anno 1606 Also of the Adjacent Country called by the Dutch Niew Nederlant Anno 1630 by Iohn Senex 1735" accompanying the tract "A Short Account of the First Settlement of the Provinces of Virginia, Maryland, New-York, New-Jersey, and Pensylvania, by the English." This tract deals with the famous boundary dispute between Pennsylvania and Maryland that lasted from 1681 to 1760. It was reprinted with John Senex' map by the American Geographical Society in 1922. The date 1606, attributed by John Senex to Smith's map, should, of course, read 1612 and is due to the insertion of the year "1606" under the word "Smith" in the second and subsequent states of the Smith map (see above, p. 438). In the circular describing the American Geographical Society's reprint the date of Smith's map is erroneously given as 1606.—EDIT. NOTE.

RECENT CONTRIBUTIONS TO URBAN GEOGRAPHY: A REVIEW

By M. Aurousseau

City geography is a comparatively recent phase of specialization. In so far as it embraces a large section of the field of human geography it is not specialization at all. To produce results of value, however, it calls for a type of student rare in the physical sciences; a type endowed with imagination almost of an artistic kind, but restrained in a rigorous way by the discipline of scientific method. The city has to be interpreted as an organic part of a social group, as well as described as a mass of materials. In this way the study is a special one, for the capable exponent is an unusual type of person.

Growth of the Subject

Oberhummer and Hassert gave the subject its first general foundations in 1907.[1] Discursive work had been done in abundance before that date, but almost up to the present time Hassert's admirable little book has been the only general work on the geography of towns. Prior to the publications of these works an important effort had been made in Dresden to understand the life and significance of the large town from a geographical point of view. The results, if somewhat one-sided, are still informative.[2]

During the period 1907–1913, when human geography was in lively growth, urban geography made rapid strides. The works of Blanchard on Grenoble and of Levainville on Rouen then appeared.[3] They remain the high level of performance, nothing of their scope and thoroughness having been produced since then. During the war years research activity in urban geography almost vanished. The subject received its due recognition, however, in 1919, when the journal *La Vie Urbaine* first made its appearance, and just recently Geisler brought matters up to date, at any rate so far as Germany is concerned, in two very able papers of general bearing.[4]

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[1] Eugen Oberhummer: Der Stadtplan, seine Entwickelung und geographische Bedeutung, *Verhandlungen des XVI deutschen Geographentages zu Nürnberg, 1907*, Berlin, 1907, pp. 66–101.

Kurt Hassert: Die Städte geographisch betrachtet, Leipzig, 1907.

[2] Die Grossstadt. Vorträge und Aufsätze zur Städteausstellung (7 papers by different writers), *Jahrbuch der Gehe-Stiftung zu Dresden*, Vol. 9, 1903.

[3] Raoul Blanchard: Grenoble: Étude de géographie urbaine, Paris, 1911 (2nd edit., 1912). Reviewed in *Geogr. Rev.*, Vol. 3, 1917, pp. 243–244.

Jacques Levainville: Rouen: Étude d'une agglomération urbaine, Paris, 1913.

[4] Walter Geisler: Beiträge zur Stadtgeographie, *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1920, pp. 274–296. Reviewed in *Geogr. Rev.*, Vol. 11, 1921, pp. 614–616.

Idem: Die Deutsche Stadt: Ein Beitrag zur Morphologie der Kulturlandschaft, *Forschungen zur deutschen Landes- und Volkskunde*, Vol. 22, 1919–1924, pp. 359–552.

Method of Study

Only one paper dealing specifically with method in urban geography is so far available.[5] The author, Blanchard, is perhaps the most able worker in the field. He considers the four major partitions of the research to be situation, site, history, and the existing city. The nature of the investigation on the spot is quite specifically outlined. In the hands of Blanchard and his students the method has proved to be eminently successful. To his technique may be added the use of aerial photographs, as recommended by Joerg,[6] an adjunct of remarkable utility in the investigation of American cities, maps of which seldom show the built-up areas. We may also suggest the need of studying the city at night or on holidays, when the people are not at work. The areas deserted at such times are significant, from the point of view of business distribution and dwelling density. The core of New York is, for example, impressively still on Sunday evenings.

Regional Study

It is an astonishing fact that the greatest interest has centered upon the individual town. Geography is so deeply concerned with the distribution of things that an interest in town distribution seems to be an obvious consideration. Little attention has been given to it. An inspection of the plans of Peking, Teheran, Bologna, and Washington, for example, is enough to suggest that the town shows a kind of racial, or national character, in its form and aspect. Reclus published a number of excellent town maps that are very informing in this respect,[7] and some of Ratzel's work is suggestive[8]; but Fleure is the only active student of the regional character of the town.[9] The general distribution and size of towns has caught Jefferson's attention. He uses a set of symbols indicative of size and evidently considers that towns, from small to large, form a graded series.[10] I hope shortly to produce the results of a study of the sizes of towns that will carry the matter a step further. Obviously then, the distribution of towns is an almost open field for investigation.

Functional Study

The functional importance of the urban group receives its full due in certain French researches to which reference will subsequently be made.

[5] Raoul Blanchard: Une méthode de géographie urbaine, *La Vie Urbaine*, Vol. 4, 1922, pp. 301–319.

[6] W. L. G. Joerg: The Use of Airplane Photography in City Geography (abstract), *Annals Assoc. of Amer. Geogrs.*, Vol. 13, 1923, p. 211.

[7] Elisée Reclus: Nouvelle géographie universelle: La terre et les hommes, 19 vols., Paris, 1876–94.

[8] Friedrich Ratzel: Die geographische Lage der grossen Städte, pp. 437–461 of Vol. 2 of Hans Helmolt, edit.: Kleine Schriften von Friedrich Ratzel, 2 vols., Munich and Berlin, 1906.

[9] H. J. Fleure: Some Types of Cities in Temperate Europe, *Geogr. Rev.*, Vol. 10, 1920, pp. 357–374. See also Robert Gradmann: Schwäbische Städte, *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1916, pp. 424–457.

[10] Mark Jefferson: Some Considerations on the Geographical Provinces of the United States, *Annals Assoc. of Amer. Geogrs.*, Vol. 7, 1917, pp. 3–15.

Idem: The Distribution of People in Japan in 1913, *Geogr. Rev.*, Vol. 2, 1916, pp. 368–372.

Idem: The Distribution of British Cities, and the Empire, *ibid.*, Vol. 4, 1917, pp. 387–394.

Idem: Great Cities of the United States, 1920, *ibid.*, Vol. 11, 1921, pp. 437–441.

As a general subject for study, however, little has so far been done. The reception given to Vaughan Cornish's book on capital cities, both in technical journals and in the contemporary press, shows how eager is the desire for information of this kind.[11]

Marinelli has made a statistical examination of certain Italian and American cities, according to the occupations of the inhabitants as shown by the census.[12] He finds that in many cities, significantly in small cities and towns, there is a dominant occupation that places the city definitely in a functional classification. The occupational analysis of the large city shows no such clearly marked character. This leads him to tabulate a group of large cities as "unspecialized types." Actually these are the most highly specialized of economic agglomerations. They are cities where professionalism, commerce, and industry are interwoven in relations of a metropolitan kind.

The Status of the Town

Society is organized on an economic basis. The units that develop in order to conduct the affairs of modern life are thus economic necessities. In geography we use the terms town, city, and metropolis in an arbitrary manner, according to the size, nature of administration, or apparent importance of the unit. Urban units, however, are strictly aligned with particular grades of economy and seem to embrace different geographic forms, perceptible to the initiate, though as yet undefined. Attention must here be directed to a kind of work likely to be of fundamental importance in urban geography.[13] It indicates clearly that the metropolis, the industrial town, and the commercial town must be treated as different geographic entities—forms in human geography, analogous, in their expression of social and economic processes, to the land forms of the physiographic processes. The metropolis, the great unit that organizes business for a wide metropolitan area, or hinterland, may even now be clearly envisaged. Extensive work is needed before the metropolis can be defined, while the forms of lower status are as yet but dimly visible in the sunrise.

The Metropolis

The great cities that can even now be accepted beyond doubt as metropolitan have been given no unified geographic interpretation. To be sure, their advantages of position are well understood. I have seen a textbook of elementary general science that made the situation of Chicago perfectly clear. But where is there an adequate work on the geography of Chicago,

[11] Vaughan Cornish: The Great Capitals: An Historical Geography, London and New York, [1922]. Reviewed in *Geogr. Rev.*, Vol. 14, 1924, pp. 156–157. On the functional aspect of city geography see also M. Aurousseau: The Distribution of Population: A Constructive Problem, *Geogr. Rev.*, Vol. 11, 1921, pp. 563–592, especially p. 572.

[12] Olinto Marinelli: Dei tipi economici dei centri abitati a proposito di alcune città italiane ed americane, *Riv. Geogr. Italiana*, Vol. 23, 1916, pp. 413–431.

[13] N. S. B. Gras: An Introduction to Economic History, New York and London, 1922. Reviewed in *Geogr. Rev.*, Vol. 14, 1924, pp. 161–163.

Paris, or Rome? The time is hardly ripe. Every metropolis has a large, if not tremendous, bibliography. The geography of the form is growing piecemeal and by attack from various angles. Here and there a solid co-ordination of results has been effected. But the geographer can produce no rounded contribution until the historian, the economist, and the engineer, to name but a few, have spoken clearly. He will not, on this account, be a mere parasite on the work of others. He must make his own extensive investigation, with its peculiar technique, on the spot and will shed on the contributory work of others an entirely new light. Metropolitan geography is incomplete, but distinct advance has been made in two cases—London (Registration London, 4,483,249 in 1921)[14] and Berlin (Greater Berlin, 3,803,770 in 1919).[15] It seems evident that metropolitan geography will be produced by synthesis rather than by individual effort.

The City and Town

Attention has centered on the city through a general and long sustained interest in its situation. Geographical literature is besprinkled with brilliant little notes and paragraphs explaining the position of this or that place, to the extent that most of the important cities of Europe have been thus "explained."[16]

Human geography, however, opened up a vast field and has led us to look closely at every detail of the town or city. It is evident here too, from the work done, that the town or city of more than 500,000 inhabitants is too great a task for a single investigator, even if provided with a library of antecedent contributory results. Rouen and its *banlieue* (to the limit of suburban tramway communication) had a population of 183,066 at the time of Levainville's investigation. If the geography of the metropolis is to be effected by synthesis, it seems that good results may be obtained for the large city by a method of symposium. Edinburgh (420,281 in 1921) and Glasgow (1,034,069 in 1921) have been dealt with in this way[17] though not completely. Other examples will be given later.

Specific Examples: Cities

Recent geographical work has been more particular than general. It has been directed towards the history of the origin and growth of the town to its present form, on the one hand, and towards internal modification of aspect on the other. Of the general kind of study we may note in passing

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[14] Population statistics, unless otherwise indicated, are taken from the "Statesman's Year-Book," for 1923. They refer to the city as recognized by the Census.

[15] See the article London: A Geographical Synthesis, *Geogr. Rev.*, Vol. 14, 1924, pp. 310–312. See also Beiträge zur Geographie Berlins (five papers by different writers), *Mitt. des Vereins der Studierenden der Geographie an der Universität Berlin*, No. 2, 1918.

[16] For the more important literature of "situation" see Aurousseau, *op. cit.*, pp. 568–575.

[17] See the "Edinburgh Number" of the *Scottish Geogr. Mag.*, Vol. 35, 1919, August-September-October, pp. 281–330; and the "Glasgow Number," *ibid.*, Vol. 37, 1921, January, pp. 1–80. Noted in *Geogr. Rev.*, Vol. 11, 1921, pp. 298–299.

a paper on the ancient capitals of Japan.[18] It is a contribution to history rather than geography but calls for notice, as it places a great amount of material in the hands of western students. Being concerned with the progressive migration of capitals during the era of conquest of the islands, it is a useful supplement to Vaughan Cornish's interpretation of Japanese capitals.[19] No attempt will be made here to give a complete summary of particular work, but a few of the most interesting examples will be indicated.

Lille is the largest city to have received satisfactory attention. The city, with its *faubourgs* and *banlieue rurale*, had a population of 385,256 in 1914. The work is the result of several studies,[20] which enable the city to be visualized and appreciated as a living thing in the light of its development and relations. The geography of Lille, nevertheless, is far from complete, the internal geography apart from certain considerations of the core itself being almost untouched. Scrive-Loyer prefaced his earlier work by a general chapter on city geography wherein he shows the importance of the fusion of potential city nuclei in the development of large agglomerations (London and Westminster are the grand example). He also enters into a discussion of the vexed question of the suburbs, distinguishing the *faubourgs*, prolongations connected directly with the built-up city proper, from the *banlieue rurale*, which produces fresh perishables and over which the city exercises special rights. Making extensive use of Blanchard's work, he shows that Lille, from the earliest times, has been a richly favored interregional town, with marked advantages both of site and situation. It has constantly turned a higher grade of advantage to account and stands now at a great European crossroads, close to an important coal field, and midway between the iron fields of Normandy and Lorraine.

Marseilles (586,341 in 1921), though a greater city than Lille and the subject of two significant investigations,[21] has not yet been clearly interpreted. Blanchard has given a most illuminating summary of the geographical setting of the city, which touches all sides of the subject, but it does little more than touch them. His primary intention was to review. Rambert's long paper is an extensive historical and physical statement but hardly deals with the life of the place at all. Not until he comes to a discussion of architecture and house types does the reader feel that the subject is being handled in a vital way. Marseilles is singular in its isolation. It is placed at a point offering the meager, but best, advantages in

[18] R. A. B. Ponsonby Fane: Ancient Capitals and Palaces of Japan, *Trans. and Proc. Japan Society, London*, Vol. 20, 1922–23, pp. 105–217.

[19] Cornish, *op. cit.*, pp. 264–271.

[20] Raoul Blanchard: La Flandre, Paris, 1906, pp. 436–443.

Idem: Deux grandes villes françaises, Lille et Nancy, *La Géographie*, Vol. 30, 1914–15, pp. 103–122.

Jules Scrive-Loyer: Les conditions anthropogéographiques du développement de l'agglomération lilloise, *Bull. Soc. de Géogr. de Lille*, Vol. 63, 1921, pp. 143–162, 199–226, and 279–308.

Idem: L'agglomération lilloise: Étude d'aménagement et d'extension, *La Vie Urbaine*, Vol. 5, 1923, pp. 415–441.

[21] Raoul Blanchard: Trois grandes villes du sud-est [Lyons, Marseilles, Nice], *Recueil des Trav. de l'Inst. de Géogr. Alpine*, Vol. 6, 1918, Grenoble, pp. 153–210.

Gaston Rambert: L'agglomération marseillaise. *La Vie Urbaine*, Vol. 1, 1919, pp. 311–328 and 469–483; Vol. 3, 1921, pp. 245–271 and 347–367.

a "zone of difficulty."[22] The situation enables it to serve the traffic problem of southern France as no other place can, but there is no hinterland to the town. The site, advantageous enough in the beginning, has offered many obstacles, which have been removed or circumvented at great cost and by enormous effort. This place, really meagerly endowed but the best on a forbidding coast, has been able to establish itself as an *entrepôt*. Thus from commercial activity it has risen to industrial rank by working over the variety of merchandise and products brought across land and sea to its quays. Marseilles enjoys a relative superiority of emplacement that makes Genoa the only possible rival. Thanks to the superiority of artificial harbor works, Marseilles will keep its ascendency.

These two cities then, Lille and Marseilles, illustrate the method of symposium applied to large agglomerations. The geography of the city is expressed by the bringing together of several contributions that are specifically geographic in their intent. First contributions have been made for a few other major cities. Blanchard has reviewed Lyons (561,592 in 1921), Nice (155,839 in 1921), Bordeaux (267,409 in 1921), Nancy (113,226 in 1921), and several other cities.[23] Dubois has similarly expressed Antwerp (304,124 in 1921), as the culminating development of Flemish life; Brussels (775,039 in 1921), as the great crossroads on a fundamental ethnic boundary; and Liége (165,136 in 1921), as the workshop of Walloon craftsmanship.[24]

First contributions have also been made for Leipzig (604,380 in 1919) and Lübeck (113,746 in 1919), and some useful material has been placed on record for Cologne (633,904 in 1919).[25] The Cologne papers, indeed, actually form a symposium, but their purpose and main content is somewhat far from being geographical in its nature.

It is more than likely that some of the cities just mentioned will eventually be found to have metropolitan status, while those of the lower order of magnitude could have been dealt with thoroughly had the opportunity been afforded to their respective investigators. The works now to be noted indicate that the task is not too formidable for a single, unaided worker.

Walter Geisler has completed an extensive research on Danzig (194,953 in 1923), wherein he shows how a preëminent site has been put to

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[22] See H. J. Fleure: Human Regions, *Scottish Geogr. Mag.*, Vol. 35, 1919, pp. 94–105.

[23] Blanchard, Trois grandes villes du sud-est.

Idem: Deux grandes villes françaises, Lille et Nancy.

Idem: Bordeaux, *Rev. de Géogr. Commerciale*, Vol. 43, 1917, Bordeaux, pp. 323–337.

[24] André Dubois: Trois cités belges: Liége, Anvers, Bruxelles, *Bull. Soc. de Géogr. de Lille*, Vol. 64, 1922, pp. 66–86.

[25] Hans Rudolphi: Das Stadtbild Leipzigs geographisch betrachtet, *Mitt. des Vereins der Geographen an der Universität Leipzig*, Vol. 1, 1911, pp. 14–35.

Christian Reuter: Der Aufbau der Stadt Lübeck von der ältesten Zeit bis zum vorläufigen Abschluss der Entwicklung um das Jahr 1300, *Zeitschr. des Vereins für Lübeckische Geschichte und Altertumskunde*, Vol. 12, 1910, pp. 3–27.

Köln (eleven papers by various writers), *Mitt. des Rheinischen Vereins für Denkmalpflege und Heimatschutz*, Vol. 5, 1911. See also Walther Tuckermann: Die geographische Lage der Stadt Köln, *Pfingstblätter des Hansischen Geschichtsvereins No. 14*, Lübeck, 1923.

intensive use and how the city, once established, has availed itself of all regional advantages one by one until, in order to maintain its status, it has had to regulate or overcome the disadvantages of the site. His contribution to method is a map showing the heights and uses of buildings within the core of the city.[26] Similar work has been done for Bremen (269,806 in 1919)[27] and Stettin (232,726 in 1919).[28] These studies are balanced in their treatment and have a definite quantitative stamp. They lack the lively spiritual understanding so evident in French work, being formally descriptive rather than vividly interpretive. They should be compared with Levainville's work on Rouen (123,712 in 1921), a city of the same class (see above, note 3).

Riga (185,137 in 1920) has been made the subject of an important study, already noted in this journal.[29] This contribution is unique in its attempt to give a conception by map of the hinterland of the port. The effects of topography and land ownership on the growth of the town have also been dealt with in an illuminating way.

A recent piece of work of slender proportions calls for attention here. Friedrich Leyden[30] by means of Heim's device of printing on both sides of a map and then using it as a transparency, is able to show a close connection between the growth of Ghent (165,287 in 1921) and its geological foundation. In the text he draws a contrast with other Flemish cities in showing that Ghent had no great market place but rather a series of markets; it had no great open spaces and hence had an exceptionally low dwelling density. Quite unconsciously he hits what are perhaps two generalizations. We owe to Geisler a realization of the conservatism of streets. Leyden, endeavoring to map the growth of Ghent according to periods, has realized the conservatism of street names. In tracing from street names the quarters belonging to remote periods, he has been forced to use the philology of suffixes—a method applied in Belgium by Marguerite Lefèvre also. Again, Ghent has few thoroughfares. The canal net and meanders of the Leie and Scheldt suffice for a large part of the heavy work of transportation throughout the city. This should be a feature of other "waterway" cities.

The Small City

Particularly modern in treatment is Levainville's paper on Caen (53,743 in 1921)[31] because of its rigorous application of economic history. The *campagnes* and *bocages* of Basse Normandie are a group of well-defined natural regions that have borne a diversified culture, based on the

[26] Walter Geisler: Danzig: Ein siedlungsgeographischer Versuch (diss.), Halle, 1918.

[27] Theodor Biehl: Bremen: Eine landschaftskundliche Stadtuntersuchung, Bremen, 1922.

[28] Hans Kröcher: Stettin: Ein Beitrag zur modernen Stadtgeographie (diss.), Greifswald, 1913.

[29] Richard Pohle: Riga, *Meereskunde*, Vol. 13, No. 8, 1920. Reviewed in *Geogr. Rev.*, Vol. 10, 1920, pp. 344–345.

[30] Friedrich Leyden: Gent, *Petermanns Mitt.*, Vol. 69, 1923, pp. 67–69.

[31] Jacques Levainville: Caen: Notes sur l'évolution de la fonction urbaine, *La Vie Urbaine*, Vol. 5, 1923, pp. 233–278.

soil, from very early times. Drainage lines make Caen the natural focal point for the traffic of this hinterland and place it in easy touch with neighboring regions. Nevertheless, no sure trace of a Saxon town can be found. The Normans used the site; but when the city first appears in history (in the eleventh century) it does so as an established foundation. It was a town devoted to marketing but was satellitic in its activities to Rouen, to which it lost its fairs (1476). Owing to varying fortunes and irregular development it did not enter into definite commercial relations until the beginning of the sixteenth century. Thence on, to the third quarter of the nineteenth century, its character hardly changed. Caen was a town in the commercial phase, handling the goods of its region well, exporting them to the Netherlands and England, and importing combustibles, wines, etc. Small industries existed, based on the products of the hinterland; but the town was essentially commercial, conservative, and unchanging. In 1873 investigation proved the existence of great reserves of high-grade, bedded hematite and siderite in the Silurian near Saint-Rémy. The ore had special uses. The fate of Caen was sealed. German capital started the exploitation, and the town stepped into the industrial phase. The port was improved, furnaces and works were erected, and traffic increased. The hinterland supplied some labor, the rest was recruited from without. Iron went abroad, and coal came back. Caen and its region are now profoundly altered. The sectionalized market town has become an integrated industrial agglomeration with an assured prosperity, and the old Caennais deplore the change. From 41,181 inhabitants in 1876 to 53,743 in 1921 is a stride, but Caen remains a town. The great neighboring city of Rouen diffuses an influence (largely financial) throughout its region, that Caen will not attain. "En Basse Normandie la vie monte de la terre; elle ne descend pas de l'usine." A prettier example of town economy would be hard to find.

Here too, in the class of small cities that are economically towns, belong such studies as Blanchard's Grenoble (77,409 in 1921) and certain papers in recent numbers of *La Vie Urbaine*, like that of Marcel Poëte on Besançon (55,652 in 1921).

Biermann's work on Lausanne (68,533 in 1920) calls for brief mention, as it illustrates particularly well the conservatism imposed upon many European towns by the period of defense of the Middle Ages.[32] The Roman foundation occupied an even space close to the lake shore on the small alluvial plain, the natural nodal point of regional routes. In the Middle Ages the town was forced to occupy a defensive position to the northwest of the smooth ground. Lausanne has since moved downhill; but the heart of the town is still determined by the fortress position, and only the modern extensions are spreading westward over the alluvial land.

[32] Charles Biermann: Situation et site de Lausanne, *Bull. Soc. Neuchateloise de Géogr.*, Vol. 25, 1916, pp. 122–149. Reviewed in *Geogr. Rev.*, Vol. 6, 1918, p. 285.

The Town

If the city and the small city have their respective classical monographs on Rouen and Grenoble, the little Galician town of Biala (8257 in 1900) has also been the subject of exhaustive treatment.[33] The method of approach here is very like that of Blanchard. Hanslik's work is particularly interesting in two ways: he shows the relations of the situation of Biala not only with regard to regional physiographic features but also with reference to important cultural boundaries; he also pays meticulous attention to the internal geography of the town.

For work of comparable importance, one must turn to the results of the energetic Grenoble school. The provincial geographic journals of France contain fairly numerous references to the geography of the small town,[34] but the work is superficial and slight. The Grenoble results, however, mark an important phase of progress. Four towns have been studied so far, each one in a thorough manner. The treatment is uniform, though by no means monotonous. The results themselves are of the greatest local interest and importance but do not yet afford grounds for generalization. As examples of procedure, however, they should claim the careful attention of the student of city geography. The four towns are Annecy (Haute Savoie, 17,241 in 1911),[35] Albertville (Savoie, *total* population 10,278 in 1911; 7320 in 1921),[36] Briançon (Hautes Alpes, 7888 in 1911; 5012 in 1921),[37] and Annonay (Ardèche, 14,876 in 1921).[38] All these works on the small town are notable for their length and their wealth of illustrations and maps.

Studies Allied to Town Planning

Town planning has a voluminous and growing literature. It is not my intention to deal with it here otherwise than to indicate it as a source of useful cartographic material. As a subject it separates itself clearly enough from city geography but may by no means be ignored. Certain studies have been made in the realm of town planning which have a distinctly geographic character.

First place must be given to the "English Catalogue, International Cities and Town Planning Exhibition, Jubilee Exhibition, Gothenburg, Sweden, 1923." This profusely illustrated work is a mine of geographical information. Arranged according to participant countries, many sections are prefaced by a statement, from the pen of an authority, on the condition of towns and cities in the countries concerned, dealing often with post-war

[33] Erwin Hanslik: Biala, eine deutsche Stadt in Galizien, Vienna, Teschen, and Leipzig, 1909.

[34] See for example P. Collesson: Grasse, ville des parfums, *Bull. Soc. de Geogr. de l'Est*, Vol. 30, 1909, pp. 232–240.

[35] Raoul Blanchard: Annecy: Esquisse de géographie urbaine, *Recueil des Trav. de l'Inst. de Géogr. Alpine*, Vol. 4, 1916, Grenoble, pp. 369–463.

[36] F. Gex: Albertville: Étude de géographie urbaine, *Rev. de Géogr. Alpine*, Vol. 9, 1921, Grenoble, pp. 5–134.

[37] Henry Petiot: Briançon: Esquisse de géographie urbaine, *ibid.*, Vol. 9, 1921, pp. 341–456.

[38] F. Thomas: Annonay: Essai de géographie urbaine, *ibid.*, Vol. 11, 1923, pp. 117–199.

circumstances. It is impossible to summarize the work, but it is recommended as a source book of urban geography. Of general bearing, too, is an article by Dario Barbieri.[39] He discerns the germs of rectilinear or radial plan in the cores of most Italian cities and is led to a discussion of the regular plan. He deplores the nineteenth century Italian outgrowth and makes an esthetic appeal for better town planning. Some informing plans accompany the article. The author regards the problem as having organic, technical, and artistic sides and thinks the solution is a kind of local expression of the threefold exigencies. Interesting examples are given.

Along the line of specific effort, the scheme for "the garden girdle of Kiel" will be watched with interest.[40] Kiel, Bremen, and other places in North Germany express their zeal for outdoor exercise by gardening. The effort increases the food supply. Kiel intends to turn this taste of its citizens to account by a zoning scheme. The industrial and residential sections of the city are to be regulated; the existing gardens, public and private, are to be extended, allowing for forest and park reserves, and the city will ultimately feed itself by its own effort. All is calculated to a nicety. City refuse will be deflected inland, by an extensive canal, pumping, and treatment system; water conservation will be undertaken; model gardens will be established; tool factories will operate; an agricultural society will be formed; prices will be regulated, etc. It is an extension of existing activities and gives fair promise of success. Of a different character is the "Report of the South Wales Regional Survey Committee" (Ministry of Health, London, 1921). Life in the urbanized area of the South Wales coal field is here examined critically with a view to its betterment. The recommendations of the committee are numerous but systematic. First, administrative boundaries must be resurveyed, in order that local authority may act more efficiently in the co-ordination of existing public facilities and communications. Secondly, units must be developed in the area at suitable places, for example a dormitory town at Llantrisant and a health resort at Porthcawl. All details of local congestion, water supply, health conditions, recreational facilities, and housing have been examined. The siting of houses with reference to topography and local weather conditions is especially interesting. If the recommendations are carried into effect the scheme will be so large as to take the character of "country planning."

City Geography in Scandinavia

The Stockholm center has long been noted for its contributions to demographic geography. The interest there is turning steadily to human geography, and, from information we have received, considerable advance has been made in the study of Swedish cities. A paper has already appeared

[39] Dario Barbieri: I piani regolatori e la fisonomia delle città, *Le Vie d'Italia*, Vol. 29, 1923, pp. 875–885.
[40] La ceinture agricole de Kiel, *La Vie Urbaine*, Vol. 5, 1923, pp. 443–450.

on Stockholm (419,440 in 1920).[41] The Danish statistical bureau publishes maps that enable the extent of the larger agglomerations to be determined,[42] and the Norwegian bureau makes occasional contributions to the problem of city population.[43] The general interest in the city problem in these countries and in Finland is bound to result in valuable contributions to city geography in the near future.

City Geography in the United States

North American interest has centered in the population geography of cities rather than in the broader questions of city geography.[44] Notable contributions have been made on several occasions by visitors to the country, the main point to receive attention being the comparison of American with European cities. During the Transcontinental Excursion of 1912 of the American Geographical Society four papers were presented by visitors dealing with various sides of city geography, one of which calls for special notice of this point.[45]

The geographical journals of the United States contain numerous articles on the geography of cities wherein the locational interest is dominant. Very seldom does a work of depth on the geography of a particular city appear. There are scattered papers on New York, and notes have appeared on nearly all the larger cities; but intensive studies are rare. There are nevertheless some notable contributions.[46] Coming to particular cities we find few that claim a written geography. For Chicago (2,701,705 in 1920), the ground has been broken by the local geographic society[47]; while certain students have shown sustained interest in New Orleans (387,219 in 1920)[48] and Duluth (98,917 in 1920).[49] Another city that has received fairly extended treatment is San Francisco (506,676 in 1920).[50]

The reasons for the lack of extended studies in the United States are to be found in the magnitude of the problem. The country is preëminently one of great cities, each class of city overshadowing in size the

[41] Sten De Geer: Greater Stockholm: A Geographical Interpretation, *Geogr. Rev.*, Vol. 13, 1923, pp. 497–506.

[42] Danmarks Statistik, *Statistiske Meddelelser*, Series 4, Vol. 63, 1921.

[43] A. N. Kiaer: Befolkningstilvekst i Kristiania og Aker, *Norges Officielle Statistik, Meddelelser*, Vol. 31, 1913, pp. 49–63.

[44] Mark Jefferson: The Anthropography of Some Great Cities, *Bull. Amer. Geogr. Soc.*, Vol. 41, 1909, pp. 537–566; also references cited in footnote 10.

L. V. Roth: The Growth of American Cities, *Geogr. Rev.*, Vol. 5, 1918, pp. 384–398.

[45] Eugen Oberhummer: Amerikanische und Europäische Städte, in Memorial Volume of the Transcontinental Excursion of 1912 of the American Geographical Society of New York, New York, 1915, pp. 163–184.

[46] See the "Boston Number" of the *Journ. of Geogr.*, Vol. 2, 1903, June, pp. 271–342 (six papers by different writers); and a group of eight papers by different writers on selected cities of the United States, *ibid.*, Vol. 21, 1922, September, pp. 205–241.

[47] See *Bull. Geogr. Soc. of Chicago*, No. 1 [1913?] and No. 4 [1914].

[48] E. F. Campbell: New Orleans in Early Days, *Geogr. Rev.*, Vol. 10, 1921, pp. 31–36.

Idem: New Orleans at the Time of the Louisiana Purchase, *ibid.*, Vol. 11, 1921, pp. 414–425.

Idem: The Port of New Orleans, *Journ. of Geogr.*, Vol. 20, 1921, pp. 337–350.

[49] Eugene Van Cleef: A Geographic Study of Duluth, *Bull. Amer. Geogr. Soc.*, Vol. 44, 1912, pp. 401–417 and 493–506; and other articles in the *Journal of Geography.*

[50] Alfred Rühl: San Francisco, in Memorial Volume of the Transcontinental Excursion of 1912 of the American Geographical Society of New York, New York, 1915, pp. 287–311 (in German).

corresponding class in Europe. And the great city in Europe has so far yielded a similar harvest of results—interpretations that are incomplete. We must admit, however, that the European work has been more extended and more penetrating. In this land of giant towns the student would do well to apply his first efforts to the small city, extending at a later date to the large city the results of a simpler experience. The outlook for the United States, however, is most encouraging. There is a lively interest in the subject, and a recent supplement to the *Annals of the Association of American Geographers* announces that eight graduate students at present proceeding to the doctorate are engaged upon various phases of work in city geography.

RECENT AMERICAN WALL MAPS: A REVIEW*

By W. L. G. Joerg

The development of American-made educational wall maps may be said to be of fairly recent date. Passing over Guyot's excellent series of relief wall maps of the sixties, which was rather a direct transplantation of the European school as represented by Karl Ritter than a native American product, the earlier efforts do not go back much farther than the nineties, as exemplified by the Columbia political and physical series[1] and by the Franklin relief series. In general they were not much more than enlargements of small maps and lacked the essential qualities of wall maps—boldness and generalization. The modern period begins with Professor J. Paul Goode's series, published in 1913–1917, which has been discussed at length in these pages.[2]

The maps here under consideration represent the first full tide of the modern period—no less than 151 maps published within a period of seven years. Of the eight series to be discussed six are historical. This does not diminish their geographical interest, for they all reflect the tendencies of the "new" history, with its broader conception of the subject as the history of civilization and its consequent emphasis on geographic conditions and economic development. Indeed history, when using so preëminently geographical a medium of expression as maps, is perforce strongly oriented towards geography. In the fields of ancient and European history these series follow well-trodden paths; excellent European, especially German, wall maps and atlases have long been available. In these subjects the main

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* J. H. Breasted and C. F. Huth. Breasted Ancient History Series. 16 maps. Denoyer-Geppert Co., Chicago, 1916–1920. Set, $26.70 to $79.40 according to mounting; single maps, $2.40 to $5.80. 32 x 44 inches.

S. B. Harding. Harding European History Series. 28 maps. Denoyer-Geppert Co., Chicago, 1916–1922. Set, $42.90 to $133.70 according to mounting; single maps, $2.40 to $5.80. 32 x 44 inches.

A. B. Hart (assisted by D. M. Matteson) and H. E. Bolton. Hart-Bolton American History Series. 24 maps. Denoyer-Geppert Co., Chicago, 1918–1921. Set, $37.50 to $115.60 according to mounting; single maps, $2.40 to $5.80. 32 x 44 inches.

Hutton Webster, D. C. Knowlton, and C. D. Hazen. Ancient History Maps. 18 maps. A. J. Nystrom and Co., Chicago, [1922–1923]. Set, $36.75 to $68.50 according to mounting; single maps, $3.00 to $7.00. 38 x 50 inches.

Hutton Webster, D. C. Knowlton, and C. D. Hazen. Medieval and Modern History Maps. 26 maps. A. J. Nystrom and Co., Chicago, [1920–1921]. Set, $47.50 to $94.50 according to mounting; single maps, $3.00 to $7.00. 38 x 50 inches.

W. L. Westermann. Westermann Classical and Historical Maps. 12 maps. Rand, McNally, and Co., Chicago, [1922]. Set, $158.00 to $173.00 according to mounting; single maps, $8.75 to $14.25. 46 x 66 inches.

C. R. Dryer, W. M. Davis, the late S. W. Cushing, Ellsworth Huntington, J. W. Redway, Frank Carney, W. S. Tower, J. Russell Smith, G. B. Roorbach, edits. Denoyer-Geppert Political Geography Series. Two series: smaller-scale, 10 maps; larger-scale, 7 maps. Denoyer-Geppert Co., Chicago, 1919–1922. Smaller-scale series: set, $50.95 to $73.50 according to mounting; single maps, $3.40 to $6.80. Larger-scale series: single maps, $8.75 to $16.40 according to mounting. 58 x 44 and 78 x 64 inches.

V. C. Finch. Commercial Geography of the United States Series. 10 maps. A. J. Nystrom and Co., Chicago, 1919. Set, $20.00 to $57.50 according to mounting; single maps, $2.25 to $6.75. 38 x 50 inches.

[1] See *Bull. Amer. Geogr. Soc.*, Vol. 43, 1911, pp. 799–800.

[2] *Bull. Amer. Geogr. Soc.*, Vol. 46, 1914, pp. 715–717, and *Geogr. Rev.*, Vol. 5, 1918, pp. 87–88.

purpose of the publishers has been to meet American conditions; according to the respective sense of indebtedness of the authors and publishers credit is given, or withheld, to such authorities as Kiepert, Spruner, Poole, Schrader, Droysen. In the field of American history there have been no foreign models to follow, and it is therefore in this field that a distinctive contribution is made—just as in the case of Professor W. R. Shepherd's excellent "Historical Atlas" (New York, 1911), which is an adaptation of Putzger's well-known "Historischer Schul-Atlas" with the addition of original sheets on American history.

Earlier American History Series

The present Hart-Bolton series is not the first American wall map series dealing with American history. At least three have preceded it: those by Townsend Mac Coun (26 maps, Silver, Burdett & Co., 1889), by E. G. Foster (41 maps, Rand, McNally & Co., Chicago, 1900–1906), and by A. H. Sanford (33 maps, A. J. Nystrom & Co., Chicago, 1914). Mac Coun's series is a very worthy publication, revealing a knowledge of the sources as well as its author's geographical sense. In the latter quality the Foster series is signally deficient, the most elementary geographical features on some of its maps not being shown even in correct geometrical outline. In certain aspects of map technique, such as the representation of relief, the Sanford series is weak, mountains generally being shown in an ultra-primitive form of "caterpillar" ridges. In the treatment of the historical subject matter this series, however, belongs to the progressive modern school. The Hart-Bolton series bears a certain "family resemblance" to it, which is probably due to the fact that the geographical editor of that series was formerly associated with the firm that publishes the Sanford series.

American History Series

But it is only with the Hart-Bolton series that a complete interplay between geographical and historical methods is attained. There is a fullness of sweep about this series which betokens a real knowledge of the subject and its geographical method of expression. The maps are constructed in proper wall-map style, the underlying bases (printed in blue) of coast line, drainage, and relief in hachures being drawn boldly. The size of the maps, 32 by 44 inches, is large enough for adequate wall-map treatment and yet small enough for easy handling. An ingenious device is used to represent the area of main importance in our earlier history, the eastern third of the country, whereby it is possible to put two maps on one sheet and thus save space. On the left side of the sheet is shown the United States east of the Mississippi; this is separated from the other map on the right by a diagonal line from upper right to lower left, thereby leaving the suitable space to represent on the same scale the Atlantic seaboard region from the Appalachian Plateau to the ocean.

The spirit of the series is illustrated by the fact that of the 24 maps two-thirds deal with such matters as exploration and colonization, military campaigns, and economic development in agriculture, industry, and transportation, limiting to one-third of the maps the conventional topics of territorial development and state politics. Exploration figures especially on the first four maps. Maps 1 and 2 are world maps showing respectively the world at the time of Columbus and world exploration to 1580. As a background to Columbus' first voyage Map 1 shows the outlines of the land according to Behaim's globe of 1492; it also shows the land and sea routes to Cathay. These two maps, as well as Maps 14 and 22 in the European history series, are on a new projection devised by the publishers, which outwardly resembles Eckert's projections[3] and Winkel's recent projections.[4] Map 3 shows the principal routes of exploration in the Caribbean, 1492–1519. Map 4, in addition to territorial development from 1580 to 1750, indicates the routes of the French explorers from Champlain to La Salle in the Great Lakes region and the Mississippi valley. In addition Map 4 shows, for about the year 1660, areas actually settled. This is an important geographical element; it is also portrayed on the two parts of Map 7 for the years 1700 and 1760. This representation is probably based on the valuable maps in Vols. 1, 2, and 3 of Channing's "History of the United States" and deals with a topic in which the assistant editor of the present series, Mr. D. M. Matteson, has already made a fruitful contribution (see the map in Vol. 6 of Avery's "History of the United States"). Map 7 is primarily a map of colonial commerce and industries and indicates, for the period up to 1774, sea routes, roads, the location of economic resources and industries, and the volume of trade. A suggestive inset shows the triangular trade routes in the Atlantic, as from England to the West Indies, New England, and return.

Map 10, likewise a two-part map of the eastern United States, entitled "Westward Movement, 1763–1803 and 1803–1829," shows, on a hypsometric background, the main and secondary roads and canals of the two periods depicted. For the later period a main road is shown leading from Hartford, Conn., to Erie, Pa., across the Hudson presumably at Newburgh and the Delaware presumably at Port Jervis, then over the Pocono Plateau, and finally due west just south of and parallel to the Pennsylvania-New York border. Contemporary authorities do not seem to justify this representation. John Melish's standard map of the United States of 1816 in 1:3,801,600 and the stock map of the United States in 1:8,000,000, bearing copyright date of 1839, in the 1844 edition of H. S. Tanner's "New Universal Atlas" both show a marked gap at the Susquehanna. Tanner's map of Pennsylvania in 1:1,500,000 published in this atlas and elsewhere confirms this gap. Roads seem to have existed along portions of this route, but they seem to have been local roads and not parts of a trunk highway.

[3] *Petermanns Mitt.*, Vol. 52, 1906, Pl. 8.

[4] *Ibid.*, Vol. 67, 1921, Pl. 24.

Tanner's maps indicate a main turnpike from Newburgh via Monticello, N. Y., Montrose, Pa., and Owego, N. Y., to Ithaca, the road here forking, one branch going to Buffalo via Canandaigua and Batavia, the other going to Erie, Pa., within New York State via Bath, Angelica, and Mayville. This route (of which the Montrose-Ithaca-Buffalo section is indicated as a secondary road on Map 10) would seem better to reflect the main artery of traffic in that region at that time than one leading across the deeply dissected Appalachian Plateau of northern Pennsylvania between the headwaters of the Allegheny and Susquehanna Rivers, which region is rough country, still sparsely settled and even to this day less supplied with through roads than almost any other district of Pennsylvania.

For the period 1829–1860 there is a map (No. 13) of the whole United States showing land and water routes—the railroads and canals that existed in the eastern third of the country and the trails that led across the western two-thirds, the two systems joining at St. Joseph, Mo. Of modern economic maps there are several. Map 19 shows the present lines of transportation and is especially valuable for its distinction between main and secondary railroads. Map 20 shows the distribution of coal, oil, and other mineral resources in the West and, in an inset, the location of oil pipe lines. This map, which is in five parts, suffers from its discontinuity. Map 21, a two-part map of the eastern United States, represents, besides the coal-producing areas, the industrial areas in general and, in the part devoted to the Atlantic seaboard region, the textile areas, in two shades of intensity of development, and the manufacturing cities, distinguishing, according to the main product, cotton, wool, silk, shoes, and clothing centers. An inset shows the distribution of blast furnaces and steel mills in Pennsylvania and the upper Ohio region. Finally, Map 22 is an agricultural map of the United States and shows the areas devoted to the cultivation of wheat, corn (each, two intensities), cotton, and alfalfa and to the raising of meat cattle and dairy cattle. A map (No. 27) has recently been added to the series, representing the population density of the United States according to the census of 1920, by counties in six grades of density.

Only two of the maps are exclusively war maps. Map 8, one of the two-part maps of the eastern United States, is devoted to the Revolutionary War. Military campaign routes are boldly shown, American in black, British in red. There is an inset showing the campaign from the Highlands of the Hudson to the lower Delaware in greater detail. Map 16, of the Civil War, on a background of state allegiance and relation to slavery, shows the raided areas. Another element of geographical interest, the gradual advance of the Federal military occupation of the South, shown by lines for successive years, is rather obscured by the areal elements of the map; indeed, this map is somewhat overburdened. The area under Confederate control on March 1, 1865, is also shown. Three insets are devoted respectively to the Virginia, Atlanta, and Vicksburg campaigns. The campaign routes in the War of 1812, the Mexican War, and the Spanish-American War are

shown on maps primarily devoted to other subjects. (American participation in the World War is shown on Map 26 of the European history series.)

From this survey it will be seen to what extent maps of geographical interest predominate. A text manual for teachers accompanies the series. Although on each map the consultant is referred to the manual for explanations it would be better not to leave too much to this medium. Because of the physical separation of map and text it is a good cartographic principle always to make a map self-contained. As to the explanation of symbols this principle should be categorical. In addition it is desirable that the explanation be given in a legend and not on the body of the map. This is clearer and helps show at a glance what topics are treated on the map. The present series violates the categorical principle in a few cases and the desirable principle in several, as on Map 13, where the symbol for Western trails is not shown in the legend. Another imperfection is that on this and other maps water and sea routes are shown in too thin a line, thereby failing to be as visible as comparable land routes on the same map. It will be easy, however, to remedy these slight defects. Besides the manual the publishers have also issued an atlas, made up of reductions from the large wall maps, lithographed in the same colors as the originals. Although the maps are not specially engraved as atlas maps and hence sometimes suffer from the great reduction, the atlas is a most useful publication. Of each of the other two series issued by the same publishers there is likewise a manual and an atlas.

Ancient History Series

Of the five ancient and European history series less need be said, as they are less distinctive. That by Professor Breasted is, for ancient history, the most complete. To say that it reflects the spirit of his "Ancient Times" and other textbooks is to say that it has much geographical bearing. Such conceptions as his "fertile crescent" of Syria and Mesopotamia here again find representation. The accompanying manual, written mainly by Professor Huth, is exceptionally good and is one of those that, laudably, refers to the sources. Of the Webster-Knowlton-Hazen series, which nominally contains 18 maps, the last four deal with periods that are not usually included in ancient history, although they are probably so grouped to satisfy the prevalent courses in "early European history." Among the latter is a valuable map (No. 17) showing the expansion of Islam from 622 to 750 A. D. Of maps of geographical bearing among those dealing strictly with antiquity may be mentioned Map No. 1, which shows the trade routes and commercial products of the ancient world, and No. 2, which shows the geographical conception of the world held by the ancients, according to Homer, Herodotus, Eratosthenes, and Ptolemy—a topic dealt with in insets in one of the maps of the Breasted series. Of the 12 maps of the Westermann series the first six deal with ancient history—mainly territorial develop-

ment. There is a tendency in this series to relegate to insets topics that might deserve representation on main maps.

European History Series

In the field of European history Map 8 of the Westermann series is of special merit. It shows, as do the similar maps in the Harding (No. 8) and Webster-Knowlton-Hazen (No. 4) series, medieval commerce and its trade routes. As do these, it shows in the Mediterranean the trade routes of Venice, Genoa, and Pisa, but it distinguishes them by color and in addition it shows, colored to correspond, the land areas chiefly tributary to the trade of these three city states—an interesting geographical element. Of the two other series dealing with European history—the Harding series with 28 maps and the Webster-Knowlton-Hazen series with 26 (or 30 maps, if the last four of the ancient history set be included)—only those maps can be enumerated that are of geographic interest: Mongol-Turkish invasions, with Eastern trade routes (WKH 5); age of discovery (WKH 6, unfortunately on Mercator's projection, and H 14, on the same projection as, and similar to, Map 2 in the Hart-Bolton series); the territories of the colonial powers in 1783 (WKH 11, likewise unfortunately on Mercator's projection; for a correct equal-area representation of the identical topic see Pl. 8 of A. Supan's "Territoriale Entwickelung der europäischen Kolonien," Gotha, 1906); population density of England before and after the industrial revolution, about 1700 and 1900 (H 18 and WKH 24; practically identical pairs of maps, both based on a metric density unit, as reflected by such densities as "128–256 per square mile," or, in other words, 50–100 per square kilometer); present population density of Italy and Germany (H 19 and H 20); present economic status of Europe (H 24 and land utilization and industrial maps on WKH 25, the other two constituting this sheet representing the relief and population density of Europe); nationalities of Europe (H 25 and WKH 26; on the latter the Czechs incorrectly shown as extending beyond the Erzgebirge and Riesengebirge into parts of Saxony and Silesia); exploration and colonization of Africa (WKH 22). Both series have maps dealing with the World War (WKH 16 shows all the fronts in Europe and the Near East, with the western front enlarged in an inset; H 26 shows only the western front).

With regard to one of these maps (H 14), however, a point should be raised. Among the land routes shown on it is one leading from Bokhara to Peking first east-northeastwards along the northern foot of the Tian Shan, then presumably through the Dzungarian Gate and along the northern mountain-rimmed edge of the Gobi Desert, then down the Kerulen-Argun Rivers to the Amur where it leaves the great plateau of Central Asia, whence the route turns abruptly to the south-southwest along the foot of the Khingan scarp until it reaches Peking. It would be of interest to know on what source this delineation is based. The fundamental researches of Albert

Hermann on the silk trade routes seem to contain no reference to it; and, while individual portions of it may be valid, it hardly seems likely that a route should have made so great a detour, especially when the much more direct one along the southern border of the Tarim Basin, which is also shown and which was followed by Marco Polo, was in existence.

Political Geography Series

The Denoyer-Geppert political geography series is a creditable set of maps of the conventional type, i. e. with areal political coloring, either by countries or subdivisions of countries, the outstanding feature. Each of the continents except Australia is the subject of a map; likewise the World, the Eastern and the Western Hemispheres, the United States, and the Eastern United States. The maps are published in two sizes; in the larger size, 78 x 64 inches, the scales are unusually large for wall maps, as, for example, 1:3,168,000 for the United States and Europe (incorrectly stated on the map of Europe as "50 miles to the inch—approximately 1:4,500,000").

Two maps in the series (designated J9 and S9a) stand out as distinctive, each representing the world on a projection that is extolled as showing "the minimum of distortion in area [*sic*] and shape." This is a new projection, likewise devised by the publishers, which is similar to the previously mentioned one used on Maps 1 and 2 of the Hart-Bolton series and Maps 14 and 22 of the Harding series. Both projections are oval in outline and have straight parallels and curved meridians; the poles, however, instead of being points are expanded to half the length of the equator in the history maps and one-third its length in the political geography maps. In the former the distance between parallels increases slightly poleward, while in the latter it is constant throughout. The resulting image is very favorable, with compression of the land masses toward the poles relieved, to a greater extent in the historical, to a lesser in the political maps. As the two projections are compromises, they of course do not retain any one of the three main attributes of mathematically developed nets; particularly they are not equal-area projections. One of the two maps under consideration (S9a) shows the world only once, on a scale of 1:25,000,000; the other (J9) shows the world five times in four different projections, twice in the new projection in 1:38,000,000 and once each in Mollweide's, Gall's "stereographic," and Mercator's. This map therefore affords an excellent means of comparing the various current projections one with another and of estimating their respective advantages and disadvantages. The publishers and the editor deserve praise for introducing this valuable tool to teachers in this country. Besides exhibiting various projections each constituent map represents a different element. The main map on the new projection, with the Greenwich meridian in the center, shows political divisions; the other map on the new projection, with 90° W. as the central meridian—thus preserving the continuity of the oceans—represents world commerce, the

volume of sea-borne traffic being shown by steamship route lines of proportional thickness. The Mollweide map shows drainage basins, the Gall map the peoples of the world, and the Mercator map the principal telegraphs and cables.

The map of the eastern United States in 1:2,500,000 is likewise an innovation. It is the first wall map of a part of the United States to appear; and it is to be hoped that it may be followed by other sectional maps of our country, preferably physical maps showing relief. This would be a distinctive contribution and open up a field that has not yet been touched.

United States Economic Geography Series

Finch's economic geography map series of the United States is a contribution of this nature. It consists of a set of plates the majority of which each contain four maps of the United States in about 1:8,000,000. The maps show the distribution of the following products and industries: Pl. 4: winter and spring wheat, oats, corn, barley and rice; Pl. 5: beet and cane sugar, apples and citrus fruits, tobacco, cotton and flax; Pl. 6: vegetables, potatoes, hay and forage, horses and mules; Pl. 7: cattle, dairy products, sheep, swine; Pl. 8: coal, petroleum and natural gas, iron ore, copper, silver, and gold; Pl. 9: manufacturing industries, meat packing and fishing, flour and grist mills, leather manufacture; Pl. 10, iron and steel industries, lumber industries, cotton manufacturing, wool, silk, and linen industries. These distributions are shown by the "dot" method made familiar in Finch and Baker's economic atlas entitled "Geography of the World's Agriculture"[5]; indeed the agricultural maps in the present series are wall-map adaptations of the corresponding maps in that atlas. The industrial maps, however, have not been published before. The dot method is a most felicitous solution of the problem of portraying statistical material areally. Each dot represents a definite unit value, so that by counting the dots one can determine the total amount within a given area of the product represented; nevertheless, when viewed as a whole, the dots have a mass effect which provides an excellent generalized picture. Under each map are graphs showing the total production of the given staple in the states of the United States and the countries of the world which lead in that staple. The map of the United States used as a base for these economic data shows relief in a rather ineffective gray shading. However desirable it may ordinarily be to show relief as a background, in this case it is unfortunate, as the gray is often deeper in tone than the tint used in addition to the dots in the case of agricultural products to show the principal productive areas. When this tint is pale green, as in the case of Map 4a (wheat), the gray drowns the green.

The economic maps are preceded by three plates. Plate 3 contains four maps of the United States, each likewise in 1:8,000,000, showing respectively: average winter and average summer rainfall and average January

[5] See *Geogr. Rev.*, Vol. 9, 1920, pp. 74–76.

and average July temperatures, with prevailing wind directions. Each pair of maps is accompanied by a set of graphs representing the average monthly amount of the given climatic element at selected stations across the country. On these maps the representation of relief is eminently desirable, and, because of the type of symbols used, it does not clash with them. Plates 1 and 2 are valuable large maps of the United States (scale 1:4,000,000). Plate 2, dealing with land utilization, shows grazing land, desert land, and irrigated land areally and agricultural land by the dot method, each dot representing 20,000 acres. Plate 1 shows population density by green dots, each representing 5000 people, and the main railroad lines in red. This method of representing population density, as compared with the usual areal one, brings out clearly the concentration around urban nuclei.

Conclusion

Inasmuch as the maps that have here been reviewed or mentioned represent numerically the great majority of all modern wall maps published in the United States it may in conclusion not be out of place to enumerate the few others that complete the list. These are, so far as known, Chamberlin's map of North America during the Great Ice Age (1913), Van Cleef's rainfall map of the United States[6], Nystrom's rainfall map of the United States based on Gannett[7], Harshberger's vegetation map of the United States[8], and Jastrow's linguistic map of Europe and the Near East (1919?). Lobeck's admirable physiographic block-diagram map of the United States, although not strictly a wall map, may also be mentioned here; attention has already been called to the method of representation employed.[9] The large productivity which the aggregate of these maps betokens and particularly the high quality of those most recently published show that we have definitely entered the path of emancipation from the slavish copying of European models and are on the way to developing distinctive wall maps suited to our own needs.

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[6] Reviewed in *Geogr. Rev.*, Vol. 7, 1919, pp. 269–270.

[7] On this source see Mark Jefferson, *Geogr. Rev.*, Vol. 1, 1916, p. 203, note 1.

[8] *Geogr. Rev.*, Vol. 10, 1920, p. 54.

[9] *Geogr. Rev.*, Vol. 13, 1923, pp. 322–323.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of March and April and Elections to Fellowship. Regular monthly meetings of the Society were held on March 25 and April 22 respectively, at the Engineering Societies' Building, 29 West Thirty-ninth Street. At the March meeting Mr. Poultney Bigelow addressed the Society on "The Colonies of Japan." The April meeting was the occasion of the presentation of the Charles P. Daly Medal to Colonel Claude H. Birdseye. After the ceremony (described below) Colonel Birdseye spoke of the work of his recent expedition (see the article "A Boat Voyage Through the Grand Canyon of the Colorado," in the April number of the *Geographical Review*) in an address entitled "Boating in the Grand Canyon."

At the March and April meetings, President Greenough presiding, there were presented with the approval of the Council the names of 50 candidates who were duly elected as Fellows.

Presentation of the Charles P. Daly Medal to Colonel Claude H. Birdseye. The Charles P. Daly Medal of the American Geographical Society was presented to Colonel Claude H. Birdseye at the April meeting of the Society. In presenting the medal President Greenough spoke as follows:

"In contrast with the changes in national politics from time to time is the work of the various permanent bureaus of the government in Washington. These afford satisfaction and pride to the patriotic observer by reason of their effective and useful work and by the high attainments and unostentatious devotion of many of the individuals who comprise their staff. Amongst these the U. S. Geological Survey is justly esteemed as embracing a personnel whose scientific reputation and authority are universally recognized. Upon it devolves the duty not only of determining the topography and characteristics of the national domain, but of following similar development in foreign lands. In this country its investigations are directed with an eye to the practical advantage of the people, as well as to scientific relations and adaptations.

"Colonel Claude H. Birdseye, Chief Topographic Engineer of the Survey, is our guest tonight to receive your gold medal. By his achievements and writings he has gained eminence in both divisions of the government service, and in according him your memorial you are giving recognition to the permanent benefits which he has bestowed upon his country. This medal is awarded by the terms of its foundation for exploration or for additions to geographical knowledge and has been given in the past to explorers Amundsen, Stefansson, Younghusband, to scientists Penck, Vidal de la Blache, Chisholm, Thoroddsen from other countries, and to our own citizens Peary, Greely, Leffingwell, Chaillé-Long, Davidson, Rockhill, Brooks, Gilbert, George Otis Smith. The present recipient is a worthy companion of the notable names I have mentioned, and it may add to our satisfaction that another of our countrymen is by its bestowal joined in fellowship with our friends of foreign birth. His military services in the Great War advanced him to high rank and added to his distinctions gained in civil life. He has published various valuable works, amongst which may be mentioned: "Manual for the Artillery Orientation Officer," "Meridian Determination," "Circumpolar Ephemeris," "Triangulation and Primary Traverse, 1916–1918." It is chiefly upon the foregoing record that the present award is made. That his occupation is also not without adventure is evidenced by his latest expedition, made last year through the Canyon of the Colorado for the purpose of a detailed survey and profile of the river

and the determination of its possibilities for the development of power and of irrigation. This dangerous and useful undertaking was successfully completed, and he will favor us with some descriptions and pictures indicating the character and episodes of the journey.

"And now, Sir, I beg that you will receive from me, on behalf of the American Geographical Society, this token of their appreciation of your valued contributions to science and at the same time of their personal admiration and regard."

In accepting the medal Colonel Birdseye modestly disclaimed any credit for the medal presented to him preferring that his associates share the honor of the award. He referred briefly to the work of colleagues and friends in the field of topographic mapping and exploration and particularly to the exploits of Frederick S. Dellenbaugh and Emery C. Kolb both of whom have made the descent of the Grand Canyon, the former as a member of Powell's expedition and the latter on a private venture with his brother Ellsworth Kolb in 1911 and again as chief boatman for Colonel Birdseye's expedition of 1923.

Award of the Cullum Geographical Medal to Jovan Cvijić. The American Geographical Society announces the award of the Cullum Geographical Medal to Professor Jovan Cvijić of the University of Belgrade. The medal bears the inscription:

Jovan Cvijić
1924
For the scholarship displayed
in his published works
on the geography of the Balkan countries
and for the originality of his field studies
on the complicated physiography
of the Karst

Professor Cvijić's substantial and original studies are well known to all students of Balkan geography. They are incorporated in part in his important monograph "La Peninsule Balkanique" (1918). In the *Geographical Review* his work is represented by the articles "The Geographical Distribution of the Balkan Peoples" (Vol. 5, 1918), "The Zones of Civilization of the Balkan Peninsula" (Vol. 5, 1918), and "The Evolution of Lapiés: A Study in Karst Physiography" (January, 1924). The last-named treats of one aspect of karst erosion—a subject in which Professor Cvijić has done definitive work.

Award of the David Livingstone Centenary Medal to Frank Wild. Announcement is made of the award of the David Livingstone Centenary Medal for 1924 to Frank Wild. This medal, founded by the Hispanic Society of America and awarded by the American Geographical Society, is given "for scientific achievement in the field of geography in the southern hemisphere." Commander Wild has had an important share in recent Antarctic expeditions. He was with Scott on his first expedition, 1901–1904; with Shackleton, 1907–1909; with Mawson, 1911–1914, on the last-named acting as leader of the western party (see Sir Douglas Mawson: "The Home of the Blizzard," Vol. 2, pp. 50–107). He was second in command on Shackleton's expedition of 1914–1917. On this occasion he was in charge of the Elephant Island party whose rescue has furnished one of the notable events in the annals of polar exploration (see *Geogr. Rev.*, Vol. 2, 1916, pp. 54–57 and 231–232). Wild was again chosen as his second in command by Shackleton on his last expedition, the voyage of the *Quest*, and assumed command on the death of the leader at South Georgia. Commander Wild has related the history of the expedition in his book "Shackleton's Last Voyage" (noted in this number of the *Geographical Review*, pp. 484–485).

Election of Corresponding Members. The Society further announces the election of Dr. Edwin R. Heath, Dr. H. L. Shantz, and M. Paul Le Cointe as Corresponding Members.

Dr. Heath, now of Kansas City, Mo., is well known for his geographical work in South America. He explored the Rio Beni region from 1879 to 1881, making both descent and ascent of the main river. It was in recognition of his achievement that a branch of the Rio Beni north of Lake Titicaca was named Rio Heath. The first statement of his explorations is given in the *Journal of the American Geographical Society* for 1882.

Dr. Shantz, of the Department of Agriculture, Washington, D. C., has traveled extensively in Africa as agricultural explorer, crossing the continent from Cape Town to Cairo. He is now engaged in further study in plant ecology in this field. He is the author of "Urundi, Territory and People" in the *Geographical Review* (Vol. 12, 1922) and is joint author with Dr. C. F. Marbut of "The Vegetation and Soils of Africa" (with colored maps), *Research Series No. 13*, published by the American Geographical Society in co-operation with the National Research Council.

M. Le Cointe, of Belem (Pará), Brazil, is the author of "L'Amazonie brésilienne: Le pays—ses habitants, ses ressources, notes et statistiques jusqu'en 1920," a scientifically executed work of encyclopedic proportions and character based on a long residence in the country (see the *Geogr. Rev.*, Vol. 13, 1923, pp. 634–636).

Recent Publications

The Geographical Conceptions of Columbus: A Critical Consideration of Four Problems. Under this title the Society is about to publish No. 14 of its *Research Series*, by Dr. George E. Nunn. At first thought it would seem as if little that is new could be presented regarding Columbus and his great enterprise, both because of the amount of what has been written on this subject and because of the newer critical researches associated with the names of Vignaud, Harrisse, and others. But the topic has so many aspects, and even the primary sources such as Columbus' own writings and the contemporary records leave so many gaps in our knowledge, that these investigators have not been able to exhaust the subject. There still are individual problems to be solved and already established conclusions to be reconsidered and possibly modified. It is with four such problems that Dr. Nunn's book deals.

The first study is entitled "The Determination of the Length of a Terrestrial Degree by Columbus." It shows that there is no reason to doubt, as do Vignaud and other critics, Columbus' statement that he had verified the value current at the time by determining it himself. The criticism is based on the assumption that a measurement of a particular degree by instruments of precision is meant. That, the author concedes, was impossible. He shows, however, that Columbus utilized existing values for the latitude of Lisbon and the Upper Guinea coast and divided the distance between them as determined by him on his voyages to Africa by the difference of latitude. Through a curious set of coincident inaccuracies the result confirmed the then accepted value of 56⅔ miles to a degree. Columbus' interest in determining the length of a degree lay in his desire to evaluate the distance in miles between the western coast of Europe and the eastern coast of Asia by means of the current estimates of this distance expressed in degrees. On the undervaluation that he derived from this calculation the theory of his first voyage was in great measured based, and this incorrect conception dominated his thought to the end.

In the second study, entitled "The Route of Columbus Across the Atlantic and Return on His First Voyage," the author shows that Columbus carefully selected his route on the basis of his knowledge of the winds and currents as observed on

the outpost islands of the Azores, Madeira, and the Canaries. On his outward voyage he first went south to start from the Canaries and thus to be able to utilize the westward current and the northeast trade winds of that latitude. On his return he went far to the north to avoid these and then turned east when in the latitude of the Azores to utilize the eastward current and the westerly winds of this belt.

The question of the third study, "Did Columbus Believe That He Reached Asia on His Fourth Voyage?", the author answers in the affirmative. Believing that Cuba was that projecting part of the mainland of Asia called on the contemporary maps Mangi, Columbus, in going southwest from Cuba and skirting the coast of the present Honduras and Nicaragua towards the south, believed that he was cutting across the gulf in the China Sea enclosed by Mangi and Ciamba, the next region to the south, and that he was following the Asiatic coast southward toward the Strait of Malacca, whence he at one time considered returning to Spain by way of the Indian Ocean. Even the eastward trend of the coast of Panama did not disillusion him because this fitted a description by Marco Polo. Nor does the fact that he himself called a part of his earlier discoveries Mondo Novo prove, as some critics have asserted, that he knew he had found a new world and not the east coast of Asia. The author shows that by Mondo Novo he designated the part of South America that he had discovered on his third voyage, the continental nature of which land he recognized. But this was not incompatible with believing Cuba and Central America a part of Asia. Indeed, his conception is probably correctly illustrated by the sketch maps drawn by his brother Bartholomew, which were brought to light by von Wieser, on which Asia and the Mondo Novo are connected through Panama.

The fourth study, entitled " 'Florida' on the Cantino Map of 1502," explains the *raison d'être* of the land area occupying the relative position of Florida or the mainland of the United States on the western edge of this important map. On it there are many names along the coast of "Florida," while there are no names on the coasts of the island representing Cuba. By a critical comparison of the names on the "Florida" coast with those given by Columbus to the coastal features of Cuba (conceived as part of Asia) on his first and second voyages and with those derived from the Corte-Real voyages, the author demonstrates that "Florida" is part of the mainland of Asia. That the eastern coast of Asia is also represented on the eastern edge of the Cantino map does not invalidate this conclusion—the map in this reflects the conflicting schools of geographical thought of Ptolemy and Marinus of Tyre.

The book is furnished with text illustrations reproducing in facsimile the portions of medieval maps that concern the discussion and with two separate original colored maps by the author representing (1) the route of Columbus on his first voyage across the Atlantic and return to show his utilization of the winds and currents and (2) the route of the fourth voyage as Columbus conceived it to be along the coast of Asia and as it actually was along the coast of Central America.

Geography in France. The publication of "Geography in France," by Emmanuel de Martonne, *Research Series No. 4a*, is announced. This continues the line of investigation carried out in "Recent Geographical Work in Europe" by W. L. G. Joerg, *Geographical Review*, Vol. 12, 1922, pp. 431–484 and "The Position of Geography in British Universities" by Sir John Scott Keltie, *American Geographical Society Research Series No. 4*, 1921.

The aim of Professor de Martonne's work is stated thus: "To acquaint the reader with the status of geographical activities in France under all their aspects by tracing the origins of those tendencies whose effects we are at present experi-

encing, by explaining the distinctive characteristics of the French geographical schools, and by giving all the practical indications which are necessary to orient oneself in the mass of publications and to keep abreast of the developments of our science." The titles of chapters indicate the scope of the work: General Characterization, Geographical Societies and Kindred Institutions, Geography in the Universities, Geography at the University of Paris, Geography in the Provincial Universities, Government Departments Contributing to Geography, The Leading Geographical Journals and Series, Conclusion. The data relate to 1923.

By reason of its philosophical treatment the book is valuable also as a contribution to the history of science.

Co-operation of the American Geographical Society in the Preparation and Publication of the "Bibliographie Géographique." The Society is pleased to announce the completion of an arrangement between itself and the Association de Géographes Français for the participation of the Society in the publication of the well known *Bibliographie Géographique*, until recently an annual supplement to the *Annales de Géographie* (see note in *Geogr. Rev.*, Vol. 13, 1923, p. 480). The Society has felt for some time that there should be participation on a co-operative basis in order to make available in this country a well rounded geographical bibliography to supplement the reviews and records now published in the *Geographical Review.* It seemed that the best means at hand to put this plan into effect was to co-operate with the editor and collaborators of the *Bibliographie Géographique*, contributing to it through the Society's library a part of the material, especially that relating to works published in the Western Hemisphere. By the terms of the agreement between the French and American organizations concerned the Society will distribute the volume in the United States and Canada, and this it will do at the price at which the volume is sold at Paris (about one dollar U. S. gold). It will be distributed free to those Fellows of the Society who request it. It is hoped that in this way the Society will be able to make a substantial contribution to the facilities for research in this country, especially among professional geographers in our schools and universities, where the need for fuller bibliographical equipment has been felt. The first number of the *Bibliographie Géographique* to contain material contributed by the Society will be the volume dealing with publications of 1923, now in preparation.

GEOGRAPHICAL RECORD

NORTH AMERICA

The Oceanic Spring off St. Augustine, Fla. Is it a coincidence that numerous sulphur springs are found near the very place of the landing in America of Ponce de Leon in his search for the fabled Fountain of Youth, or did the legend originate from the fact of the existence of these springs? The "Fountain of Youth," a spring in the city of St. Augustine, recorded as a landmark in an old Spanish grant, is still preserved as one of the numerous and varied attractions for visitors.

Most interesting geographically, however, is the curious natural phenomenon of an oceanic spring off the coast. It bubbles up with marked surface disturbance through fifty feet of water from the ocean bed; in fact were the outlet of this spring on shore, it would probably resemble a geyser rather than a spring. The existence of this spring, nine miles southeast of the city of St. Augustine, has been known for a number of years; and its position has been shown on charts of the locality as in latitude 29° 46′ 05″ N. and longitude 81° 12′ 29″ W., about two and one-quarter miles off the coast.

In connection with a hydrographic survey of the east coast of Florida in 1923, a special investigation of the spring was made by Lieutenant A. M. Sobieralski of the U. S. Coast and Geodetic Survey. The investigation consisted of a hydrographic development of the vicinity, together with the collection of surface and bottom samples of the water, and surface and bottom temperature observations. Lieutenant Sobieralski's report gives the following description. "The location of the spring may easily be detected by the appearance of the water; noticeable swirls, similar to those in a swiftly running stream, can be seen at a distance of about a mile. At times, especially in rough weather, there is a marked disturbance of the water—a yellowish color which trails off to the northeastward. In choppy weather, a 'slick' is the most noticeable feature. In fact, it has all the appearance of a shoal or reef.

"A closer view shows a slick swirl with a slight overfall, the center of the swirl moving about 100 feet, first to the eastward and then to the westward, and a noticeable streak of current to the northeastward. The swirls and overfalls vary rapidly in intensity, as though large bubbles or intermittent volumes of water were being emitted. A boat will be thrown out of the swirl so that it is difficult to hold it in position.

"A strong odor, quite similar to the smell of water from the various sulphur springs of Florida, is noticeable, and under favorable circumstances can easily be detected two miles away."

The water is described as unpalatable and decidedly brackish in taste. The density is not greatly different from that of the ocean water in the locality. The temperature observations indicated no noticeable differences in temperature, either on the surface of the spring or at the bottom, from the temperature of the surrounding ocean water. And the surrounding ocean water has little difference in temperature between the surface and bottom at the depth found in the vicinity of the spring. The ocean floor in the vicinity is thus described: "The ocean bed in the vicinity of the spring is comparatively level and about 55 feet deep, composed of fine gray sand. The spring emerges from a hole only about 25 feet in diameter and 125 feet deep, or 69 feet below the surrounding ocean bed. This peculiar formation . . . is the most remarkable feature of the spring and gives an indication of the enormous volume of water which must be emitted, for otherwise the fine sand

composing the ocean bed would soon level off the hole. To the northeast of the center of the spring, the hole is enlarged to a diameter of about 300 feet; this shape of the enlarged hole probably directs the current from the spring in the northeasterly direction noted on the surface."

G. T. Rude

Land Hunger and the War of 1812. An hypothesis of geographical interest is advanced by Mr. Louis Morton Hacker in explanation of the part played by the West in the War of 1812 (Western Land Hunger and the War of 1812: A Conjecture, *Mississippi Valley Hist. Rev.*, Vol. 10, 1924, pp. 365–395, Cedar Rapids, Ia.). "Ships, seamen, and cargos" were of little concern to the frontiersman. The reasons usually advanced—vindication of the national honor, riddance of an unfriendly power to the north, removal of the Indian threat—are not entirely convincing. In the frontiersman's slogan "On to Canada" Mr. Hacker finds an expression of territorial desire.

In the first decade of the last century the frontier was roughly defined by the edges of a wedge thrust into the continent with its apex at the confluence of the Mississippi and Ohio Rivers, though isolated communities had transgressed beyond these confines. The census of 1810 showed about a million settlers in the Ohio valley. For the most part they were engaged in the expansive and wasteful husbandry that characterizes a pioneer society. Large areas of virgin soil were needed: the frontier settler was continually on the move, "it was his wasting land that drove him on. Hunger was the goad." The settlers of the Ohio valley faced a great country beyond the Mississippi, but the prairies had little attraction for them. "The prairies," believed the pioneer and the farmer of the Ohio valley, "could not be tilled because they were so far removed from the centers of communication, the rivers; because they did not furnish an adequate water supply for drinking and for the erection of mill seats; because they were unhealthful; and because they were bare of that natural element so important in the life of the farmer of the early nineteenth century—timber."

On the other hand the occupants of the Ohio valley looked to the St. Lawrence with rich bottom lands still untouched by the plow. Contemporary accounts furnish glowing pictures. "One may well imagine the hope that such a passage as the following aroused: 'The country around Lake Ontario is almost everywheres extremely fertile, particularly that part which lies at the western end and on the Niagra River. Perhaps this is excelled by no part of the world. . . . The soil along Lake Erie is excellent and that of Huron and Superior is understood to be generally good. Perhaps no country on the globe could furnish such inexhaustible stores of ship timber as that which surrounds Lake Erie and Ontario.' To the farmer this meant easy transportation, mill seats, abundant harvests, and fuel, fences, and farm buildings. If the United States was to have room for expansion, the proper direction for its energies was to the north."

EUROPE

Geography and Proposed Territorial Reorganization in Italy. "For various reasons, during the last few years, the problem of the division of Italy into regions has greatly stirred the public. Since the World War, regionalistic tendencies, which had seemed dead or dormant, have here and there come to life again, and one political party supports a program of regional autonomy." With these words Professor Olinto Marinelli begins an important monograph that appeared in two recent numbers of *L'Universo* ("La divisione dell' Italia in regioni e provincie con particolare reguardo alle Venezie," Vol. 4, 1923, pp. 839–858, 915–954). A larger

territorial unit than the present province is generally deemed necessary if urgently desired improvements in the administration of justice, of education, of the army, etc., are to be effected. It is also needed in connection with electoral reforms.

The map shows that Italy is split into sixteen major divisions: Piedmont, Liguria, Lombardy, Venetia, Emilia, Tuscany, Marches, Umbria, Rome, Abruzzi and Molise, Campania, Apulia, Basilicata, Calabria, Sicily, and Sardinia. These major divisions—until 1911 called *compartimenti* in the *Annuario Statistico*, since then called *regioni*—have no legal or administrative status and are officially recognized as statistical units only. There are several serious objections to the apparently simple procedure of directly converting the old *compartimenti* into administrative divisions. Marinelli summarizes these objections thus: "Not to mention the defects of the provincial circumscriptions which they bring together, the *compartimenti* have their own defects: either because in their composition more regard was had for history than for geography or because they are not all fortunate in their names or because of their overwhelming inequality in area and population or finally because they take no account of the economic, demographic, and social developments of the last sixty years."

The problems, therefore, present themselves of forming wholly new administrative circumscriptions and of reorganizing the provinces, on the effective grouping of which the new circumscriptions must inevitably be based. Professor Marinelli believes that the geographer can give valuable advice leading toward the solution of these problems by "marking out the natural areas within the limits of which civil and economic history have progressed each in its own way in the past or may so progress in the future; regions to which it will be opportune as far as possible to adapt administrative circumscriptions." He shows that the methods of detailed research developed by the leaders in the modern science of human geography can here be turned to markedly practical ends. His immediate purpose is to prepare the way for a thoroughgoing discussion of the entire subject at the Ninth Italian Geographical Congress at Genoa (April, 1924). This he undertakes to do, first by outlining certain principles and, secondly, by showing how these principles might be applied in dealing with a particular region—the so-called three Venetias. The monograph as a whole is a stimulating essay in what we may style "applied human geography."

Four fundamental principles are set forth by Marinelli, as follows: (1) each region should diverge as little as possible from a certain mean area; (2) it should diverge as little as possible from a certain mean population; (3) it should correspond, at least approximately, to an "historico-natural" or "economico-natural" region; and (4) it should possess an historic or economic center. The criteria for determining the limits of the natural, historic, or economic regions which are to serve as the bases for the anthropogeographic regions; the relative importance to be given to each of these three elements; the extent to which present provinces should be reorganized and new provinces created—these are matters of detail which can be solved for each region only after prolonged research into local conditions and history, research of a type suggested by the scholarly second part of Marinelli's paper.

The problem of administrative boundary drawing does not present difficulties of this character in a new nation like the United States, where territory, state, or county lines are marked out before the country is settled or during its formative period. On the whole, the delimitation of areas both large and small is a simple matter of geometry and surveying. In Italy, on the other hand, every new administrative boundary must represent a series of compromises between the demands of nature and economics on the one hand and, on the other, deeply ingrained traditions and customs that are the inheritance of more than two millenniums of civilized occupation of the land.

The American, brought up to accept the federal principle, will find certain passages and quotations in Marinelli's monography of particular interest. These reveal a profound distrust of federalism in the minds of many Italians, a distrust understandable in view of Italy's disunited past and the evils which disunion for so many centuries imposed upon her. Any movement toward local autonomy is apt to be looked upon as a movement of political retrogression. The new regions envisaged by Professor Marinelli are presumably intended to serve the ends of administrative convenience and efficiency alone.

Cotton Raising in Sicily. In the *Bollettino della Reale Società Geografica Italiana* (Series V, Vol. 12, 1923, pp. 492–512) Professor Sebastiano Crinò discusses the problem of cotton raising in Sicily. The enormous rise in the price of raw cotton since the World War has placed an intolerable burden upon Italian manufacturers, and it is hoped that relief may be afforded by the encouragement of cotton growing on Italian soil. Sicily, as distinguished from the African colonies, is extraordinarily well adapted by nature to this purpose. Backward methods of agriculture and the fear of taking risks, however, have prevented the people from making the most of their natural advantages, though the possibility of successful cotton raising on a large scale was impressively revealed during the American Civil War. An attempt is being made by demonstration and experiment fields to educate the people in more effective agricultural methods.

Cotton crops are now grown almost exclusively on a series of isolated alluvial plains along the southern coast and in small patches around the borders of the argillaceous plain of Catania. There is no question but that larger areas could be brought under cultivation with more modern methods. At present most of the raw cotton is shipped by rail to Naples, Genoa, Turin, and especially to Lombardy.

It has been shown, according to an authority cited by Professor Crinò, that the mean production of cotton per acre in Sicily is twice that of India or the United States. Under irrigation the production may be raised to very much higher figures. Indeed, Professor Crinò concludes that government encouragement in the construction of proposed mountain reservoirs is of first importance in the development of Sicilian agriculture, whether in cotton or in grains.

An Irrigation and Hydro-electric Project in Sardinia. The recent construction of a huge dam across the Tirso, the largest river in Sardinia, and the impounding of the waters into a great artificial lake foreshadow notable future economic progress in the island. Two geographical circumstances have contributed to keep Sardinia in a relatively backward condition. One of these has been the lack of coal resources, the other has been the climate: specifically, the uneven distribution of rainfall throughout the year.

A concrete example of the evil effect of the high cost of coal is the recent enforced suspension of tramway service in Cagliari. Sardinia is rich in other minerals, particularly zinc. Were coal readily available, prosperous metallurgical industries might have sprung into existence, but, as it is, the minerals of Sardinia have been exported in the raw state, and the benefits accruing from their manufacture have been reaped elsewhere. It is expected that the hydro-electric power generated by the water flowing from the new lake and by power stations to be built elsewhere will bring about an industrial era. Much confidence is placed in the development of the use of electricity in the metallurgical arts and particularly in its application to the manufacture of zinc products.

As in other parts of the Mediterranean zone, the uneven distribution of rainfall throughout the year has not only prevented the growth of local industries based upon water power but has exerted an extremely restrictive influence upon agri-

culture. Most of the rain comes in the winter and early spring. During the long, dry summers the streams dwindle away. When the freshets have passed, stagnant pools of water linger in the channels of the rivers breeding swarms of Anopheles, or malarial mosquito. Such a deadly scourge is malaria that, as in Sicily (see *Geogr. Rev.*, Vol. 14, 1924, pp. 144–145), much of the open country is abandoned altogether during the hot season. This disease and the constantly recurring droughts render agriculture precarious and unremunerative in large tracts of country of high potential fertility. Some of the largest of these tracts will be brought under irrigation by water derived from the Tirso lake, and the regulation of stream flow should go far toward eliminating the menace that lurks in the stagnant pools.

The project of the Tirso lake is described by Marcello Vinelli in *Le Vie d'Italia e dell' America Latina*, Vol. 30, 1924, pp. 201–210. Vinelli's claim that the Sardinian lake is the largest artificial lake in the world is entirely unfounded. This lake is 20 kilometers (12.4 miles) long by 2 kilometers (1.2 miles) wide in some places and has a capacity of 416 million cubic meters (109,854 million gallons). The Ashokan reservoir, which supplies New York City, is slightly larger; the Aswan reservoir in Egypt when full has more than twice the capacity; the lake impounded by the Roosevelt dam in Arizona has nearly four times the capacity; not to mention Gatun Lake in the Panama Canal Zone with a capacity of more than fourteen times that of the Tirso lake!

Military Tunnels in the Glaciers of the Ortler. Italian and Austrian operations in the Alps during the late war presented novel problems in military engineering. On the great Ortler massif alone some 36,400 feet of tunnels were excavated through ice at altitudes of over 9800 feet. Experience in their construction and maintenance during the war and their subsequent history have served to make clear several important matters regarding the nature and movements of glacial ice (see the discussion, with most interesting photographs, cartograms, and cross sections, by Guido Bertarelli: Le gallerie di guerra nei ghiacciai dell' Ortler, *Le Vie d'Italia*, Vol. 29, 1923, pp. 760–774).

Most of the tunnels encircled the heads of glaciers, keeping close to the steep walls of the cirques and ridges above and thus providing communication between positions which otherwise could not be reached without the danger of exposure to enemy observation or fire. The largest of the tunnels, however, was constructed by the Italians directly through the mid-course of the Glacier of the Zebrù not far above a point where the glacier plunges with a confusion of crevasses and *séracs* over an ice fall. This Galleria di Capanna Milano, while not the longest of the tunnels, was no less than 10 feet wide by 8 feet high. An Austrian tunnel was built to the highest summit of the Ortler (12,808 feet).

Several of the tunnels were excavated through relatively thin mantles of ice at high altitudes. Here it was observed that snow falling in winter seemed to be converted rapidly into ice despite the fact that there was no pressure from overlying masses of snow. The ice in some of these positions was found to be almost stationary. Even where it clung to precipitous slopes, the tunnels through it were unexpectedly permanent, and many of them were still intact as late as 1922. On the other hand, the congelation of snow accumulated from avalanches was relatively slow; and great difficulties were experienced in maintaining tunnels through such accumulations. The history of the Capanna Milano tunnel illustrates the law that the mid-course of a glacier moves more rapidly than its upper reaches and the center more rapidly than the margins. Furthermore, the central part of this tunnel "underwent a pressure from beneath upwards and a twisting from right to left." As a result, the walls, floor, and roof were squeezed together at a rate of about a meter every two or three months; and constant, arduous labor was necessary

to prevent the obliteration of the passageway. Since the war the tunnel has been completely destroyed, though traces of its former entrance were in evidence in 1922 far below in the ice fall.

It appears that glacial ice does not readily transmit sound. On one occasion the Austrians were able to construct a tunnel within 100 feet of an Italian position, without being detected, and thereby to launch a disastrous attack.

The Geographic Regions of Russia. The project of a complete and systematic description of Russia according to its geographic regions was launched in February, 1920, by the Commission for Study of the Natural Productive Forces. The project was suggested by the situation presented of political reunification accompanied by extreme economic disintegration, particularly in the realm of transport. A summary account of the work of the commission by G. P. Blok states: "The latter circumstance necessitated a transformation of the entire economic system, beginning with a large measure of decentralization; and, to this end, the first requirement was to arrange the partition of Russia into districts, each of which, resting on a definite economic foundation, would possess within itself the possibility of existence independent of the center of economic life." The commission proceeded to mark out such regions and undertook to make them the basis of a new general description of the country under the title "Rossia."

Up to date, its interest lies rather in the plan than in the actual work, of which only a few parts dealing with the Astrakhan country, prepared before the general design had taken shape, have been published. This plan differs from that followed in the standard compilation of Semenov and Lamanski chiefly in the principle of regional division adopted. In place of such designations as "Moscow and the Upper Volga" and "The Upper Dniepr and White Russia" we find "Central Industrial Province" and "Western Agricultural Province." Twenty-three volumes, each dealing with one such region, are planned for European and Asiatic Russia. The plan also provides for uniformity in treatment of the various topics considered under each region, with a general editor for all chapters on each of the seventeen divisions of subject matter in addition to the editors of the different volumes.

Although little progress has been made with the literary task, the actual process of decentralization was at once begun by the government, resulting in the formation of thirty-two federated autonomous republics within what is left of the territory of the former Russian Empire. Although, owing to political considerations, these creations did not correspond exactly with the regions marked out by the geographers—some are larger and some smaller—a relationship is clearly apparent. Thus the Tatar Republic, established by decree of May 29, 1920, presents a slightly reduced version of the projected "Eastern Agricultural Province" of the commission's plan. Two republics, the Ukrainian and the Crimean, were set up in the proposed province of South Russia; while practically three such provinces were incorporated into the principal state with its capital at Moscow. A cursory examination suggests imperfections in both the plan of the commission and the action of the government; perhaps both are destined to undergo modifications. As regards the former, the political partition has led to an anticipation by local bodies of the general project of description. The Eastern Academy at Kazan, for example, proceeded to launch a rival "Geographical Description of the Tatar Republic," of which the first part appeared in 1922.

From the above-mentioned facts it appears that the studies of geographic, ethnographic, and economic specialists have influenced the recent territorial reorganization of Russia even more directly and from an earlier date than is indicated in the article on this subject published in the April number of the *Geographical*

Review. The twelve "economic regions" therein mentioned as having been outlined in 1922 are probably the twelve "provinces" of European Russia provided for in the scheme of the commission drawn up two years previous to that date and before the reorganization was actually begun. (For further discussion of the twelve economic regions, with map, see H. Blink: Rusland als landbouw productieland, *Tijdsch. voor Econ. Geogr.*, Vol. 15, 1924, pp. 89-118.)

J. V. Fuller

AFRICA

Ghardaia: A City of the Desert. On the threshold of the Algerian Sahara lies the plateau of the Shebka, 8000 square kilometers in area, a country that might have come out of Dante, stony desert, *hamada*, in all its horror. "Without fear of contradiction it may be said that the world has few regions so disinherited." Here where it would seem that "the sole idea of human establishment would be in defiance of the natural conditions of soil and climate" are the oases of Mzab, and in them the peculiar and highly individualized characteristics of oasis settlements are illustrated surpassingly well. These oases have often been described. Brunhes took them as one of his oasis types, especially describing the struggle for water therein. A recent work by Marcel Mercier (La civilisation urbaine au Mzab: Étude de sociologie africaine, Algiers, 1922) discusses them as urban communities, from which viewpoint they are entirely distinctive.

The desolate Shebka appears not to have been inhabited in prehistoric times; but it was anciently a land of transit, and toponymic features point to occupation by an Arabic-speaking people before the arrival of the present occupants, the Beni Mzab. The Beni Mzab are Abadites, a heretical sect of Islam, who fled thither in the eleventh century. In 1011 the first of five cities in the Wadi Mzab was founded; within the ensuing 50 years the four other cities. Five centuries later three other settlements were established at some distance. Founded as cities of refuge, the settlements must at first have been predominantly agricultural in character; but their situation in a transit land inevitably led to commercial development. Today the total population of the Mzab is 43,000 (census of 1921). Ghardaia, the chief city, has 11,000 inhabitants and best exhibits the urban characteristics of the Mzab settlements.

The appearance of the city from the distance proclaims the urban stamp. Rising out of an arid landscape it has itself a bare appearance: a mass of serried white or grey houses rises tier on tier up the sides of a butte crowned by a quadrangular minaret; not a tree is to be seen. The city is well-ordered in plan, quite unlike the usual Saharan town, groups of houses scattered haphazard in the midst of palm groves. This distinction from the "nonchalant insouciance" of the Saharan architects betrays the origin of the Mzab in the Tell. And herein the cities of the Mzab have a unique interest. Like all isolated communities the Mzab are intensely conservative; newer cities as well as the older ones preserve features largely lost elsewhere through successive Arab invasions.

Ghardaia exhibits, at least to some degree, a feature that Sten De Geer has emphasized as a criterion of urban development—differentiation into subregions according to function (cf. Sten De Geer: Greater Stockholm: A Geographical Interpretation, *Geogr. Rev.*, Vol. 13, 1923, pp. 497–506). The heart of the city is the mosque, on the culminating point of the butte. The town grew around it, as the medieval city of temperate Europe grew around cathedral or castle. The mosque is at the same time the citadel. Here is guarded the city treasure, and provision is made for time of siege. It is the moral and social center; the seat of the religious government, the schools, baths, prison. Houses are ranged around on concentric streets occupying the sites of old fortifications, pushed farther and farther out as the city expanded. The inhabitants recognize the distinctive character

of this section, giving it a special name signifying "center of the city." Here no outsider may take up his residence.

At the base of the hill the new town envelops the old, and here the streets are straighter. A secondary center, of economic character, has developed in the south and southeast, where the ramparts have been dismantled. Occupying a typical marginal position in the southwest is the market place. Daily and weekly markets are held, the latter only assuming real economic importance. Here on Thursday evenings gather the nomads who bring the town a large part of its provisions.

FIG. 1—Plan of the city of Ghardaia reduced from Plate II of "La civilisation urbaine au Mzab." The original was executed by the French army probably about 1910.

Through the market runs a new road, tangent to the city hill and forming the most populous thoroughfare.

The Abadite, originally an agriculturist, has been forced by necessity to become a merchant. A large percentage of the male population is always absent in the Tell, and in the city itself there is a well-marked industrial quarter. Aside from the merchants that deal in certain everyday needs, such as the sellers of vegetables and leather water bottles, whose establishments are scattered through the city (even these avoid the high town), the industrial section is sharply localized round the market place. Along the new road are the shops that cater especially to the wants of the nomads: there are the sellers of stuffs and weapons, of grains and dates; the shoemakers; the cookshops near the hostelries; the carpet merchants, the ware for which Mzab is most famous. Here also are the blacksmiths and tailors, two trades that have become professional as opposed to family occupations. The complexity of the town society is increased by the existence of quarters occupied by strangers, an Arab quarter in the northwest and a Jewish quarter—there are 1400 Jews in Ghardaia—in the east.

In the Mzab settlements various types of habitation may be seen—tents on the outskirts of the towns, chiefly occupied by nomads engaged in transport, and typical Saharan huts of *jerid* palm branches and leaves or adobe; but the chief and distinctive habitation is the Mzab house. The narrow, open streets are bordered by whitewashed masonry houses comprising a ground floor and an upper story, part

covered, part terrace. A zoning law is in operation as regards height, which must not exceed six meters in the center of the town, seven meters outside it, and eight meters in the oasis gardens. There are 1815 houses altogether in Ghardaia, which gives an average of nearly six persons to a house; that is the individual family unit and not the kinship unit customary in Islamic countries. The houses are close-pressed; and, while the court is of fair proportions, the rooms opening off are small and narrow. The city of Ghardaia occupies 21 hectares (52 acres). The density of population thus is 476 per hectare, a figure of distinctly urban order. M. Mercier compares it with Paris with 128 persons per hectare in the residential section of the Champs Élysées and 741 in a poor and crowded quarter. The Borough of Manhattan, New York City, has 400 persons per hectare.

There is no production of food in the city itself. Even the goats, of which each family possesses one, must be sent out to pasture. Ghardaia has four goatherds. Every morning at a fixed hour they betake themselves to the appointed city gate "et fait entendre certains cris très prolongés au même instant, les portes des maisons s'entr'ouvrent, les chèvres sortent des habitations, se rendent d'elles-mêmes auprès du berger qui les attend et se groupent sur la petite place." They set out at sunrise and return only at sunset, going more than 20 kilometers for pasture.

Outside of the cities, to which they present the sharpest contrast, are the oases proper. These fresh, luxuriant gardens, unlike many oases where stagnant water exists, are very healthful for they are irrigated from well water quickly absorbed by the soil. That of Ghardaia is a kilometer and a half from the city and extends for three kilometers up the wadi. In summer the heat renders the city almost uninhabitable, so that the entire population betakes itself to the oasis, moving *en masse* in a single, moonless night, when the edict for exodus is given. Formerly temporary shelters were used; but within the last 50 years, it is said, permanent houses resembling those of the city have been built. Here is in evidence the feature common to all oasis settlements—the question of water supply. Ancient and precise regulations are in operation for its management and distribution, and therein is created a solidarity and democracy that counteracts the tendency to hierarchy in the city. Furthermore, the garden villas are larger than the town houses and accommodate the kinship group. Seeing the spaciousness of the gardens, once access is gained through the heavy wooden doors like those of the town houses, one would have no idea of the state of subdivision that exists; single palms are not infrequently the subjects of special property rights, but the irrigation canals are common property. During winter there is a constant coming and going from town to oasis; in summer it is reversed, the town being visited only for business matters and on market days. The gardens, however, are not pleasure resorts but places of exploitation. Their care demands unceasing labor.

It would be interesting to compare the cities of the Mzab with Siwa. This oasis of the Libyan desert, so famous for its dates, has been charmingly described by C. Dalrymple Belgrave in a recent book, "Siwa, The Oasis of Jupiter Ammon" (London, 1923). Siwa also is peopled by an ancient Berber stock and is built on the summit and sides of two limestone rocks rising abruptly from the plain. As the population increased new houses were built on the top of old ones, so that the inside of the town is now "a vast warren." More recently the town has spilled out on the plain; and here are country houses, where the wealthy retire in the summer when the heat of the town becomes intolerable.

Life in Timbuktu. Life in Timbuktu, the Mysterious City, is not the lotus-eating existence of some European travelers' descriptions. The hard facts are presented by Dupuis-Yakouba, Chief Agent of Native Affairs for French West Africa, who declares that "la plus grande activité règne dans cette région et qu'il

faut aux habitants de Tombouctou une ingéniosité de tous les instants pour arriver à se procurer nourriture et vêtements." In "Industries et principales professions des habitants de la région de Tombouctou" (*Publs. Comité d'Études Historiques et Scientifiques, Gouvernement Générale de l'Afrique Occidentale Française*, Paris, 1921) he gives a truly living picture of the industrious workers of the city and its district. Most of the city dwellers are engaged in commerce, but in the region as a whole a great variety of occupations is represented—from butchers, provisioned largely from the flocks of the nomads, and bakers to the "professions sanitaires." Most fall in the groups of manufacturing, extractive, commercial, and agricultural industries. Personal initiative is largely paralyzed by the existence of a sort of caste system; the exercise of most trades is hereditary. Shoemakers, for instance, are descendants of the Moroccan invaders of the sixteenth century.

The volume is furnished with abundant illustrations of instruments and products: thus for the building industry, which is not a closed trade, we have sketches of the mason's tools and plans and ornamentation of houses. Many interesting details are given. The houses, for instance, never face east or west, the directions of the prevailing winds, that they may be saved "the ills and malignant influences carried by the wind." Fishing—the chief extractive industry, for the Niger is extremely rich in fish—is illustrated by drawings and descriptions of 27 species of fish and illustrations of the canoe, nets, lines, and harpoons used. Fishing entails a seasonal movement. At the time of low water the fishing folk disperse to their favorite grounds to make and dry their catch; then the women and children return to the villages while the men peddle the fish in the towns.

The many intimate details include the cost of rent and laundry. In spite of the modesty of the rental, from 2 to 2½ francs for a room and from 10 to 15 francs for a house per month, a landlord in Timbuktu can thereby meet the daily expenses of his family. A laundress gets 25 centimes a garment if she provides her own soap and bluing (indigo). Among auxiliary industries hairdressing offers much scope, for coiffures are elaborate and varied according to race, state, and condition. Timbuktu is a desert town; its reservoirs, excavations in the sand filled by infiltration from the Niger, often dry up, wells are salty, and drinking water is retailed from house to house. Such water formerly cost .02 to .03 centime per skin bottle; now raised to .05 centime. The class of professional entertainers includes musicians and story tellers. The public gatherings of the latter have been largely curtailed, for under French régime curfew rings at 6 P. M. in Timbuktu! This is perhaps a little unfortunate, the harmless entertainment being "une des manifestations de contentement publique, l'indice de la tranquilité politique des habitants." The liberal professions number *imams* and *muezzins*, engaged in the service of Allah, the cadis and village chiefs, public letter writers, and teachers. The "profession sanitaire" in Timbuktu is now limited to a veterinary, who, however, does more business as a horse dealer. There is no doctor at present; a Moroccan who formerly practiced the healing arts with remedies imported from his native land—"il les cédait naturellement contre un bon prix"—apparently made his fortune and retired.

But, as we have said, the absorbing interest of Timbuktu is in commerce. This city of some 7000 inhabitants (census of 1921) might be described as a vast covered market. There are two public market places which are given over to retail sale, purchases being made with silver or copper coin. The wholesale transactions are carried on in the houses and consist essentially of barter of salt for grains and stuffs. The city, in fact, lives on salt; and many industries, including the hostelries and transportation, are subsidiary thereto. This commodity comes from the Taodeni mines, 18 days' journey to the north. The mines are worked by slaves of rich Moroccans or people of Aruan, from which latter oasis or from Timbuktu the mines are provisioned. Two annual caravans bring in the salt to Timbuktu, and it is sold largely to the Mossi who distribute it through the Niger bend. A minor occu-

pation is that of the salt markers, who inscribe the bars with an invocation to a saint and an ornamental design at 2 centimes apiece.

The Climate of Khartoum. Scorching hot days in summer, with hot nights too; hot days even in winter, but the nights cool; searing aridity, at times with no moisture at all in the air and for rain a dozen showers in July, August, and September, when southerly winds and a few clouds replace the steady northerly winds and fearful glaring sky of the dry time—more than half of these showers thunderstorms following *haboob* sandstorms, which blow for three or four hours a brisk gale, only agreeable for its welcome cooling. Such is the general picture of the "dry and scorching climate of Khartoum" (L. J. Sutton: The Climate of Khartoum, *Egyptian Ministry of Public Works, Physical Dept. Paper No. 9*, Cairo, 1923).

Once in the last 21 years the thermometer went up to 117°. Never since 1901 has it failed to climb up to at least 109° some day in May or June. In 18 years out of the 21 it has done it in April, and nine times in July. It is the accustomed thing in May and June to see the mercury reach 103° at noon, go on to 107° at about half past three, to settle back at 103° at six! Most terrific afternoons. There is little variation from day to day, and two months like that are to be expected.

The nights do not give much relief. Just before sunrise, the usual coolest moment in these two months, the temperature is at 80°. Occasionally it drops to 72°, and once in 21 years it fell to 67.5°. That is the lowest record for May and June. Within doors, where it is always much hotter than out at the thermometer shelter, it seems as if those must be bad nights to sleep. No doubt observers on the ground could tell us interesting things about that. Even in January, the coldest month, the afternoons as a rule warm up to 86°; occasionally to 95°; and once a temperature of 102° was recorded. But then the nights are cool, dropping to 59°; occasionally to 49°; there is one record of 40.3°, the lowest venture of the Khartoum thermometer, so that frosts are quite unknown and unlikely.

As Khartoum is within the tropics the temperatures are very regular, the means of successive days rarely differing by 2°. In rainless November this variability falls to 1.6°; in August, month of most showers, it rises to 2.7°. The greatest change ever known in two successive days was from the 12th to the 13th of July, 1907. A rainstorm on the second day dropped the temperature from a mean of 89° to one of 75°. Details, which are not given in the report, would be interesting. The August rains are explicitly stated to be cooling.

The air is extremely dry: at times the relative humidity is practically zero. "On occasion the air is dry enough to dry up calcium chloride exposed in the shade." The average relative humidity for the year has the extremely low value of 28 per cent, ranging from 13 in April to 49 in August.

The rainy season—it should rather be called the season of the rains—is from May to October inclusive. There are only five showers in August, the rainiest month, even if you count a tenth of a millimeter as a shower, which is exaggeration. Four or five good showers usually give August its 2.72 inches of rain. May has 0.12, June 0.28, July 1.77, August 2.72, September 0.71, and October 0.20—in all 5.83 inches for the year. The driest year, 1901, had 2.52 inches; and the wettest, 1922, 14.40. The rains are closely associated with the winds. No rain falls from November to April, while the wind is steadily northerly. In the season of the rains calms are three times as frequent, and nearly half the winds are southerly—25 per cent southwest, 17 south, and 4 southeast. Twenty-four per cent of the winds are still from the northern quadrant. The rains come on as a low barometer area advances from the south to establish itself over the Red Sea in July and August.

As already stated, there are not many showers. Sixty per cent of them are thunderstorms, frequently succeeding *haboobs* which thereby acquire climatic im-

portance. But what is a *haboob?* The picture is not very clear: "a very unpleasant type of sandstorm" met with more or less frequently throughout an area of about a half million square miles around Khartoum. At that station they have twenty or thirty a year. They come at all seasons but are four times as frequent in the six months of the rains. Their winds, never measured nor even estimated apparently, are only exceptionally strong enough to unroof verandas, overturn light Decauville tramcars, uproot trees in exposed places, and overturn river steamers. The *haboobs* of the dry season mostly come from a northerly quarter. In the season of rains, however, almost all come from the south or from points between south and east. Mr. G. W. Grabham, the Sudan government geologist and the observer from whom most information seems to be drawn but who is unfortunately not quoted, regards them as a collection of traveling, circular storms. This is well shown in two photographs (facing p. 54). The dust is frequently raised to heights of 1000 meters. "Within the storm the wind direction certainly varies. The frontage of the storm probably reaches twenty or thirty kilometers." They last three or four hours, "are very frequently accompanied or followed by lightning, and in July, August, and September by rain, and there is invariably a subsequent fall in temperature." It is not quite clear whether that means that the dry season *haboobs* also cool the air or only the rainy ones. Considering that 175 of them were recorded within 6 years, that is a very meager account.

But the element of human reaction to the weather is one of which little use is made in the report. The human body animated by an observant mind is an instrument that, within very definite limitations, has a high value for climatology and for meteorology; witness the most instructive personal narratives of experiences in many parts of the world that Hann used so effectively in the second and third volumes of his "Klimatologie."

Most of us never experienced anything like the climate of Khartoum. How do white men get along with it? What defenses do they adopt? Do they have to recuperate occasionally in other climates? Do they quickly suffer in health? In what way does it affect them? Have the natives good health? Mr. Sutton gives us typically the following. "The dry heat of May and June is very trying, but some relief is brought by the drop in temperature which accompanies the rains of July and August." On one or two occasions reference is made to descriptions by Mr. J. T. Hirst, the resident observer, and by Mr. Grabham; but there are no quotations from them. Khartoum has no thermograph, no barograph, no automatic recorders of either wind or rainfall. Such instruments would have surely shed much light on the *haboobs* that figure here so tantalizingly and on that drop in the temperature of July, 1907; but lacking these the observer's notes would certainly have been worth publishing. Abundant experience with reports published by meteorological journals has shown that the most admirable discussions of climate have been made by men who combined instrumental measurements of various phenomena with the workings of an observant mind, especially as this reacts at once on the instrumental record by adding opportune special readings in weather emergencies. Publication of his notes with such editing as they may demand reacts on the observer by keying up his attention and sharpening his power of observation.

The greatest of all climatologists set an example in that regard that might well be followed. Geographers owe an unpayable debt to meterologists and climatologists for every observation they have made and every instrument they have constructed or set up. We are grateful for all their work. We like their critical attitude with regard to their instruments and their exposure. We are grateful for the pains they take to average and add and smooth our curves by harmonic analysis; but respectfully we set forth that they are dependent on intelligent observers from the start and that an intelligent observer can report many climatological items that no instrument can record.

AUSTRALASIA AND OCEANIA

Depopulation in Melanesia. The decline of population and of the well-being of the native in many parts of Melanesia is the cause of grave concern to informed observers. The reception of two articles on the subject by the Melanesian Mission has resulted in the production of a slim volume of essays by authorities well known in Melanesia as administrators and students (W. H. R. Rivers, edit.: Essays on the Depopulation of Melanesia, with a preface by Sir Everard im Thurn, Cambridge, 1922).

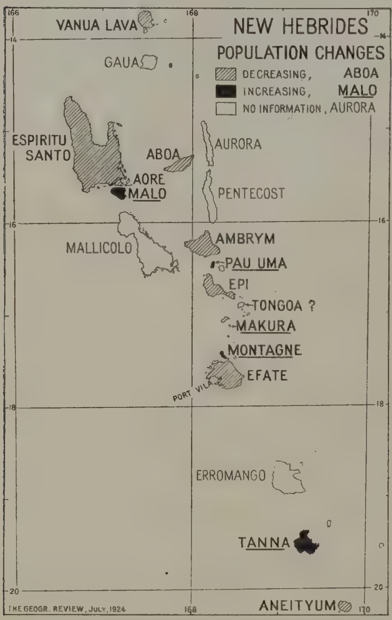

FIG. 1—Sketch map of the New Hebrides showing the preponderant movement of depopulation.

The book deals with the New Hebrides, the Solomons, and the intervening groups of islands. There is no census in most parts of Melanesia. The facts presented are hence based on scientific method only in Rivers' essay. Elsewhere they depend on estimate and opinion, which, however, are trustworthy. The accompanying map indicates the existing conditions in the New Hebrides, as far as they have been stated in the volume.

The seven essays and introduction to the volume are contributions from unusually able authorities—men with a firm grip on Melanesian affairs and years of local experience behind them. All agree on the serious nature of the problem and agree in general as to its causes and treatment. At the root of the matter seems to be the disintegration of the native social fabric by the white man, who has given nothing in return except in a few meager examples, as in the New Hebrides where the missions, by grafting Christianity on to the native social organization, have effected a transfer from barbarism while retaining its better elements. This, as on Tanna, has been brought about by the policy of Sir William Macgregor in New Guinea—the upholding of native authority by capturing the interest and co-operation of native chiefs.

Opinion is expressed that the movement of depopulation in Melanesia was in progress prior to the arrival of the whites, owing to decadence in native society. The criteria of decadence are vague. Unnecessary exaggeration of ritual, custom, and form suggest a line of inquiry. Such influence certainly operated in parts of the New Hebrides (Aneityum), and Monckton gives an account of weapons in the Trobriand Islands which indicates that the people had long finished with war as a serious business. Beauty of design and great size were more considered in the manufacture of spears and shields than their effectiveness as weapons. He also refers to the Papuans between East Cape and Cape Vogel as a miserable and decadent lot (C. A. W. Monckton: Some Experiences of a New Guinea Resident Magistrate, 4th edit., London, 1921). Evidently the possibility of progressive decline in parts of Melanesia, not in any way connected with white civilizing influence, is a point to be borne in mind, though the essayists are not in agreement about it.

The general decline now taking place is attributed by all the writers to certain phases of white "civilizing" influence. The proximate causes of depopulation are

those affecting the health of the native—the subtle spread of epidemics, especially those of a pulmonary nature, after the visits of apparently clean ships; the slower spread of other white man's diseases; the effects of alcohol, as in the southern New Hebrides; the wearing of unnecessary clothes. A deeper-lying cause is to be found in the effect of the plantation system on native society. The recruiting of labor is still a bad business, and in the New Hebrides the methods vary—French planters may recruit women, while British may not. Terms of indenture and the conditions on many plantations are open to improvement. The home village is deprived of its marriageable young men (and perhaps women) for years. The repatriate has "seen life" and returns with the opinion that his chief is after all no very important person and that village life is pretty slow. He livens it perhaps by setting up business as a chief himself; and the hold of local government is weakened, while the recruiting vessel becomes a haven of refuge for criminals. For all these evils, feasible measures of administration are suggested.

But the root of the matter lies deeper still. Rivers' essay on "The Psychological Factor," strongly endorsed in Sir Everard im Thurn's preface, is perhaps the most important one in the book. Rivers advances his conclusions with no great emphasis, and it requires a knowledge of the man himself to realize their weight. A man of unusual brilliance and perhaps the ablest psychologist of Great Britain, he studies Melanesian anthropology in a rigorously scientific way, evolving novel and original methods such as the pedigree method of studying native population (for an account of Rivers' work see C. S. Myers: The Influence of the Late W. H. R. Rivers on the Development of Psychology in Great Britain, *Rept. British Assn. for the Advancement of Science, 1922*, London, 1923, pp. 179–192). Briefly Rivers' conclusion is this: The Melanesian has lost his interest in life. The tremendous psychological consequences of his spiritual condition are resulting in his extermination. It is shown, for instance, that the pursuit of head hunting in the Solomons was interwoven with the whole fabric of his religious and social life. The complete suppression of this pastime, without making adequate substitution for it, amounts to taking the springs from a clock. Primitive society is a complicated structure built out of elusive things (see H. Newcombe Wright: Primitive Law and the Belief of the Survival of Death, *Law Quarterly Rev.*, Vol. 34, 1918, pp. 380–391). Interference with it is only justified on the basis of a thorough appreciation of the significance of its manifestations to the native mind. Melanesian society has been ruined for the most part by good intentions. New Caledonia, the Loyalty Islands, and Fiji are not considered; but the depopulation of Fiji has been investigated, the "Suva Report" being well known (Report of the Commission Appointed to Inquire into the Decrease of the Native Population [Colony of Fiji], Suva, 1896).

Petroleum Prospecting in Australia. Competent judgment, within or outside Australia, has never endorsed the popular belief that commercial supplies of Australian petroleum must exist. In so large a country, where detailed geological investigation has covered a relatively small proportion of the ground, similar and well justified reserve in qualified opinion has caused geologists to refrain from a dogmatic assertion that oil will not be found. The government geologist of New South Wales has now expressed a matured opinion (E. C. Andrews: Prospecting for Petroleum in Australia, *Econ. Geology*, Vol. 19, 1924, pp. 157–168). He reviews the history of mineral prospecting in Australia, showing that the work has been done by capable men whose trained eyes were eagerly seeking all the profitable deposits of the earth's crust. None of these men encountered petroleum in commercial quantity. He then reviews the results of petroleum prospecting in the individual states. Beyond several indications of a none too promising nature, the results have so far been negative. The geological structure of Australia is then

considered briefly in a comparative way. He shows thus that the relation of the Australian land mass to the nearer commercial oil regions is similar to that of Peninsular India and South Africa—regions that have yielded nothing yet to prospecting. Mr. Andrews concludes by saying "If we may judge by the experience of oil prospecting outside Australia, the value of the expectation of securing crude petroleum in commercial quantities within the area under consideration is small and is not to be considered as a business proposition by small investors."

POLAR REGIONS

The Voyage of the "Quest." In "Shackleton's Last Voyage: The Story of the *Quest*" (London and New York, 1923) Commander Wild sets out to relate "a plain and simple narrative . . . the more popular story of the expedition" leaving scientific results for separate publication. The narrative is indeed told with admirable restraint; and at the same time, with the appendixes by various scientific members of the personnel, it gives a good idea of the character of the results attained. It is clear that there was accomplished a considerable part of the program, the main object of which was "the taking of observations and the collection of scientific data in Antarctic and sub-Antarctic areas" and which did not aim "at the attainment of the Pole or include any prolonged land journey." It will be recalled that Sir Ernest Shackleton's original plans had to be changed—from exploration in the Beaufort Sea and the region of Stefansson's "Pole of Inaccessibility"—to the Antarctic. The *Quest*, selected with a view to Arctic exploration, proved less suitable for Antarctic waters; and, furthermore, the expedition was handicapped by engine trouble throughout. This caused, for instance, a month's delay at Rio on the outward journey. The *Quest* sailed from Plymouth September 24, 1921, and reached South Georgia January 4, 1922. On the way one objective was visited, the St. Paul Rocks. Geological specimens were collected, and a new large-scale chart (200 feet to the inch) of the rocks and the surrounding submarine plateau was made.

In South Georgia the expedition was overwhelmed by the sudden death of the leader. Command now devolved on Wild who, in a situation rendered specially difficult by the delays encountered, decided to carry out the original plans as far as possible. The route lay eastward. A running survey of Zavodovski Island, the northernmost of the Sandwich group, was made. The nonexistence of Pagoda Rock was practically proved, a sounding of 2980 fathoms being obtained two miles east of the charted position. The *Quest*, now several degrees within the Enderby Quadrant, was headed south into the pack. She was pushed through the ice with increasing difficulty to latitude 69° 18′ S. and longitude 17° 11′ E. Shortly before attaining this position a depth of 1089 fathoms had been found. This represented a shoaling of 466 fathoms in 29 miles and suggested approach towards the continental shelf. "I felt sure that if we could only work our way for another fifty miles to the south we should sight or find indications of land," says Commander Wild. But it was not possible. Reluctantly the *Quest* was headed north and worked to the margin of the pack, along which she skirted for some 2500 miles to the westward. Whilst in the Enderby Quadrant her course lay approximately between that of Bellingshausen (1820) and Biscoe (1831). At 64° 11′ S. and 46° 4′ W. the *Quest* was within 40 miles northeast of the position assigned to Ross's "appearance of land," but no indications of land could be discerned though the day was clear: soundings gave a depth of 2331 fathoms.

The *Quest* proceeded westward as far as Elephant Island, a spot of vivid memory to those members who had been of the *Endurance* party in 1916. It was not possible to land at the old quarters, but a rough survey was made of Cape Lookout

anchorage where a supply of sea elephant blubber was obtained to eke out the coal until South Georgia could be reached. At South Georgia a series of over two hundred soundings was taken; it was shown that the 200-fathom line extended much farther to the southwest than had been believed. Possibilities of trawling and the establishment of a fish-curing station are indicated. Sketch charts of several of the harbors of the island were made.

FIG. 1—The route of the *Quest* in the southern hemisphere. Based on the map (p. 79) accompanying Commander Wild's paper "The Voyage of the 'Quest'," *Geogr. Journ.*, Vol. 61, 1923, pp. 73–105.

The *Quest* now proceeded to Cape Town, visiting the Tristan da Cunha-Gough Island group on the way. Investigations were made on the geology and natural history of the several islands, and elevations were taken. The highest point of Tristan da Cunha was reduced from 7640 feet to 6400. Dr. A. H. Macklin took a census of the population and to the volume contributes two interesting chapters on the islanders. Few signs of degeneration were found; the people were rather regarded as intelligent and healthy. Dr. Macklin, however, calls attention to the occasional introduction of new blood through temporary settlement of shipwrecked sailors. Tristan da Cunha is on the direct route from Cape Town to Buenos Aires, and the aviator member of the party considers that a good site for an aerodrome is available. The reported guano deposit of Nightingale Island was proved to be of no economic value. Gough Island offers much of interest in landscape and vegetation. Here the expedition spent five days, the only scientific expedition that had visited the island previously being that of the *Scotia* in 1904, which spent one day there. A new chart of the island was made with important corrections. The highest point, named Mt. Rowett in honor of the patron of the expedition, is situated centrally and has an elevation of 2915 feet; previous charts recorded 4380 feet in the northern part of the island. A reef reported by whalers in latitude 35° 4′ S. and longitude 5° 20′ W. was proved nonexistent. On the homeward trip from Cape Town St. Helena, Ascension, St. Vincent (Cape Verde Islands), and the Azores were visited, primarily for comparative geological purposes.

Arctic Tides and the Hypothetical Arctic Land. Northward of Alaska lies the vast unexplored region surrounding what Stefansson has called the "Pole of Inaccessibility." Whether this region is land or sea is still an open question. After his discovery of ocean depths along the route of the *Fram*, Fridtjof Nansen, in a series of detailed studies, concluded that the Arctic Ocean comprised an open basin of deep water occupying all, or nearly all, of the unexplored area north of the known land masses. ("The Oceanography of the North Polar Basin," London, 1902; "The Bathymetrical Features of the North Polar Seas, With a Discussion of the Continental Shelves and Previous Oscillations of the Shoreline," London, 1904; "On North Polar Problems," *Geogr. Journ.*, Vol. 30, 1907, pp. 469–487 and 585–601). But from a detailed study of the tidal and current data of the Arctic, R. A. Harris found it necessary to reduce the extent of the open polar basin and to assume an area of shallow water, an archipelago, or a tract of land to the north of Alaska. ("Some Indications of Land in the Vicinity of the North Pole," *Natl. Geogr. Mag.*, Vol. 15, 1904, pp. 255–261; "Arctic Tides," Washington, D. C., 1911, pp. 90–103; "Undiscovered Land in the Arctic Ocean," *Amer. Museum Journ.*, Vol. 13, 1913, pp. 57–61).

The tidal observations that Harris had at hand were very meager; and the cotidal chart he constructed to show the progress of the tide in the Arctic was necessarily based, to a considerable extent, on theoretical considerations. Along the north coast of Siberia, from the mouth of the Yenisei River eastward to Pitlekai on the Chukotsk peninsula—a distance represented by more than 100° of longitude—no tidal observations of any kind were at hand.

This question of Arctic tides and their bearing on the existence of undiscovered land to the north of Alaska, Jonas Ekman Fjeldstad considers in a preliminary report on the tidal observations made by Amundsen's party aboard the *Maud* during the years 1918–1921 ("Litt om tidevandet i Nordishavet," *Naturen*, Vol. 47, 1923, pp. 161–175). During the winter of 1918–1919 tidal observations for a period of three months were made at Maudhavn on the north coast of Taimir Peninsula (approximate longitude 105° E.); during the winter of 1919–1920 a series of observations covering eight months was obtained at Ajon Island (longitude 169° E.); and during the winter of 1920–1921 observations over a period of six months were made at Cape Serdze Kamen (longitude 172° W.).

On the basis of the tidal data secured by Amundsen's party, Fjeldstad constructs a new cotidal chart showing the progress of the semi-daily tide for the greater part of the Arctic. This cotidal chart differs considerably from that of Harris, for Fjeldstad assumes an uninterrupted channel across the pole from Greenland Sea to Bering Sea. It is interesting to note, however, that from the results of these tidal observations he considers that the depths assumed by Nansen for the unexplored region are somewhat too great.

Fjeldstad concludes that in so far as the semi-daily tides are concerned there is no need of postulating the existence of a large land mass in the Arctic, though shallow water and perhaps islands may be found north of Beaufort Sea. But he gives little consideration to the daily tide and none to the direction of the current, so that Harris' arguments for the necessity of a tract of land, an archipelago, or an area of shallow water in the Arctic cannot be considered as invalidated by the recent tidal observations. It is to be hoped that the *Maud's* drift across the Arctic will shed further light on this interesting geographic problem.

H. A. Marmer

Notes on Surface Markings in Spitsbergen. Under this title J. S. Huxley and N. E. Odell discuss the curious polygonal markings occurring on fairly level surfaces in high latitudes or high altitudes (*Geogr. Journ.*, Vol. 63, 1924, pp. 207–229).

A large surface is found to be covered with a polygonal pattern, the common borders of the polygonals being made up of large stones, and the interiors of finely comminuted mud. The polygonals vary in size from less than a foot to 60 feet or more across; but in any one area the sizes are fairly uniform. Sections across them show that the mud extends down five to ten inches to the frozen soil below and that under the stone border there is a small gutter in the frozen soil. It is these curious forms that the authors describe and illustrate with pictures and diagrams.

They cite the two most important hypotheses that have been advanced to explain the markings. But first we may lay down certain fundamentals: (1) the material is derived by frost action from the underlying rock, or from an old moraine. (2) The markings are due to frost action, as they occur only in places where this is active. (3) The stones in the border have been moved outward by a centrifugal force, for the mud is often rucked up against the stones and frequently has gentle undulations throughout; the stones, if flat, stand up on edge; where an isolated form occurs, it is circular; where many occur in juxtaposition, they are polygonal; all indicate pressure from the various centers.

Högbom found that stones in a finer water-soaked matrix, subjected to repeated freezing and thawing, were brought to the surface, though he offered no satisfactory explanation. He explains the polygons by supposing that the matrix, expanding on freezing, pushes the stones outwards; and, on thawing and contracting, the smaller particles but not the larger stones are drawn back; thus in time all the larger material would be collected at the border. Nansen thinks that such a process would not be effective until a fair amount of fine material had been developed and suggests that it is preceded by nivation about small snow patches. This seems rather supplementary than contradictory to Högbom's ideas.

The authors accept both these views and add to them. They point out that the rate of comminution will increase as the material becomes finer; also that the large stones have a higher heat conductivity (better diffusivity) than the water-soaked mud; therefore during thaws they will melt the gutters in the ice, allowing the thaw water to run off and keeping the stones clean; the mud will retain the water by capillarity and be ready for the next freeze. They think that freezing begins at the surface of the frozen soil and not at the upper surface of the mud; this may be so at times but not at all times. A study of the propagation of temperature variations into the earth, making allowance for the water-ice latent heat, might clarify the outward movement of the stones.

Several other forms, related to the polygons, are described; and the observations are given in much detail. They are all considered transitional forms, changing slowly; frost action will finally comminute all the material. The fairly uniform size of the polygons in a given area and the varying sizes in different areas are not understood. Reference may also be made here to observations on an allied phenomenon in the French Alps by M. André Allix, "Nivation et sols polygonaux dans les Alpes françaises" (*La Géographie*, Vol. 39, 1923, pp. 431–438).

Harry Fielding Reid

GEOGRAPHICAL NEWS

The Unveiling of the Memorial to Francisco P. Moreno. In November last the University of La Plata unveiled a memorial to Francisco P. Moreno, Argentina's foremost geographer, who died at Buenos Aires in 1919 (see *Geogr. Rev.*, Vol. 9, 1920, p. 69). In addition to his distinguished work as explorer and boundary commissioner, Moreno will be remembered as the organizer of the La Plata Museum, an institution specifically devoted to research. Moreno's work was recognized by the American Geographical Society in 1909 by the award of the Cullum Geographical Medal. On the invitation of the officers and council of the University

of La Plata the Society was represented at the memorial ceremony, Mr. Willing Spencer acting in this capacity. The following report is transmitted by Mr. Spencer.

On the afternoon of November 19, 1923, a few invited guests gathered in the central hall of the Museum for the unveiling of the bust of Dr. Moreno. There were present amongst others the President of the University, Dr. Benito Nazar Anchorena; the Minister for Foreign Affairs, Dr. Gallardo, with his wife and daughters; the Ministers of Government, Public Works, and Finance; Mr. Willing Spencer, Counselor of the American Embassy at Buenos Aires; Señores Casás, Rodriguez, Juarégui y Viale; the Director of the Museum, Dr. Luis María Torres; members of the family of Dr. Moreno, including Señores Eduardo Moreno, Francisco and Eduardo Moreno, Jr.; Dr. Ernesto Quesada; Sr. Clemente Onelli; and professors of the various institutes and faculties of the University.

After the playing of the national anthem Dr. Gallardo uncovered the bust of Dr. Moreno. Dr. Torres then initiated a series of speeches, himself reading an exhaustive biography of Dr. Moreno. Dr. Ernesto Quesada followed, speaking in behalf of the Historical and Geographical Institute of Brazil, which he represented. Dr. Quesada gave a brief history of the development of the Museum of La Plata. He went on to speak of Dr. Moreno's personality and in this respect said: "The outstanding features of Moreno's personality—leaving aside the appeal of sentiment—were, as you know, his decided scientific vocation, and the evident stamp of his autodidactic development, with all the advantages and shortcomings of such an *extra universitatem* preparation. All of Moreno's works during his entire life are touched with this mark and bear this unmistakable double seal. His determined vocation infused him with an energy which knew no obstacles, and the fact that he was self-taught led him to surround himself with specialists of methodical and solid preparation for whatever task he undertook, both inside and out of the Museum, in the practice of his duties as expert in the matter of boundaries, and in everything entrusted to his management. His observation penetrated the remotest corners. He marked out each course and directed it himself from the prow. He had technical experts execute what his intuition forecast; he saw to it that the work was done in the very best way possible and that it should stand out as an achievement. He was, in this sense, an ideal museum director. His own scientific labors reduced themselves little by little to the indispensable, until they became deliberately a mere side issue, so that he could concentrate thought and will to directing the work with energy, carefully selecting his collaborators, inspiring them at all times with an *esprit de corps*, and zealously supervising the accomplishment of their tasks. He was, in reality, a remarkable general-in-chief of a well disciplined army of exemplary training; he laid down definite rules and regulations for everything; he assigned to each his line of action; he was the stimulus of the whole working day, the very soul of the Museum, the incentive of its research, the instigator of the labors of the chiefs of sections, and it was he who made isolated endeavors converge in a common purpose, keeping always in view the advancement of national science. . . ."

The ceremony closed with a few brief words by Sr. Clemente Onelli, who made a presentation to the Museum of certain effects belonging to Dr. Moreno, to be kept in the institute as relics of the illustrious scientist, its founder.

Obituary

Prince Roland Bonaparte, President of the Paris Geographical Society, died on April 14, 1924, in his sixty-sixth year. A grandnephew of Napoleon, he was not concerned with royal aspirations but devoted himself rather to scientific pursuits. A number of his publications deal with the Dutch colonial empire. Three of these together cover the voyages of the Dutch to New Guinea from 1595 to 1885. Another

deals with the first settlement of the Dutch on the island of Mauritius. Several publications are devoted to ethnography. One of these, illustrated by anthropological photographs, discusses the peoples of the South American colony of the Dutch ("Les habitants de Suriname: Notes recueillies à l'Exposition Coloniale d'Amsterdam en 1883," Paris, 1884). He also studied the Lapps and the Kalmuks. Several papers deal with the glaciers of the French and Swiss Alps. To his family's ancestral home is devoted "Une excursion en Corse," Paris, 1891. He was a contributor to the valuable collective work entitled "Le Mexique au début du XX^e^ siècle" (2 vols., Paris, 1904), of which the 70-page section on population and colonization is due to his pen. His early predilection for historical geography is evidenced by the later publications "Documents de l'époque mongole des XIII^e^ et XIV^e^ siècles" (Paris, 1895) and "Les idées géographiques à travers l'histoire."

Since 1889 Prince Roland Bonaparte had been a Corresponding Member of the American Geographical Society, in the development of which he on numerous occasions showed a friendly interest. In July, 1921, he presided at the celebration of the Paris Geographical Society's centenary with the personal charm and democratic affability for which he was noted.

GEOGRAPHICAL REVIEWS

A Detailed Study in Mexican Anthropogeography

Manuel Gamio and Others. **La población del valle de Teotihuacán: El medio en que se ha desarrollado, su evolución etnica y social, iniciativas para procurar su mejoramiento.** Vol. 1, Part I: cii and 362 and xvi pp.; Part II: pp. 367–778 and xii; Vol. 2, 670 and xxx pp.; maps, diagrs., ills. Direcc. de Antropol., Secretaría de Agric. y Fomento, Mexico, 1922. 11½ x 8 inches.

The Valley of Teotihuacán is known to most travelers who visit Mexico as the site of the ancient monuments, the so-called Pyramids of the Sun and the Moon. It is more than that, however. It is the great natural highway from the east into the Valley of Mexico: a highway over which prehistoric migrations undoubtedly passed, through whose wide gateway armies of ancient and modern times have marched, and through which trails, roads, and railways have been built to connect the heart of the country with the almost equally populous eastern valleys of Tlaxcala and Puebla, as well as with cities along the Gulf coast. In fact, the selection of this site for those ancient monuments was probably due to its importance as a great natural highway.

Moreover, in this wide passageway existed several of the most ancient pueblos on the Anahuac Plateau. These scattered agricultural settlements, with their old stone and adobe houses, the ancient landmarks that bound their fields, and their irrigation systems, are of almost as great anthropological importance as are the clusters of prehistoric monuments about which they are grouped. Few spots in Mexico lend themselves so well for a study of the modes of life that have characterized man's occupation of this region.

It is this district, with its associations running back into hoary antiquity but still inhabited by the descendants of the ancient settlers, that forms the subject of study in Dr. Manuel Gamio's work, recently issued by the Mexican government's Department of Anthropology. The work in question is primarily an anthropological treatise, but it includes also a brief, systematic description of geographical conditions and throughout never loses sight of the geographical setting. Throughout the pre-Hispanic period, the colonial era, and the present times, in the minute description of the life and culture of the valley, human activities are shown to be closely related to the land. The reader sees how lines of communication developed along this great natural highway and its tributary valleys; how irrigation farming resulted from the scanty rainfall and the porous character of the soil; how the distribution of the people, the type of dwellings, the mode of clothing, the folklore, and the system of landholding are connected with the physical conditions existing in the region.

The descriptions are characterized by thoroughness of detail: in fact, few districts of the world have been the object of such detailed treatment. Numerous illustrations (drawings and photographs) together with many topographic and geological maps add greatly to the graphic character of the volumes.

Additional value is lent this work by the fact that, while in several respects the Valley of Teotihuacán differs from other parts of Mexico, in many ways it is a typical section of the populous Mesa Central which for ages was one of the centers of densest population and highest culture on the American continent. The work affords an excellent cross section of Mexican history and Mexican life as it exists upon the Central Plateau.

That such a study could have been carried on and almost brought to completion during the troubled years of revolution adds credit to the department that produced it and the guiding head of the enterprise.

Dr. Gamio has shown his often expressed desire to have the English-speaking scientific world take a keener interest in the affairs of Mexico, by issuing an abridged form of his study in that language (Introduction, Synthesis and Conclusions of the Work, "The Population of the Valley of Teotihuacan," by Manuel Gamio, Dept. of Anthropology, Secretaria de Agric. y Fomento, Mexico, 1922). Such a result will probably be obtained, and there will also result an increased appreciation of the work being done by such Mexican students as the author of these monumental volumes.

G. M. McBride

The Plan and Site of Tenochtitlan

W. L. Hare. **The City of Mexico.** Maps. *Garden Cities and Town Planning,* Vol. 13, 1923, pp. 135-142.

The cities of a lost civilization are rarely known in plan as they existed when peopled. The reconstructions of archeology, however accurate, are skeletons. Mr. Hare has made a study of the valley of Anahuac, and of Tenochtitlán, primarily to understand the routes and movements of Cortes, whose own despatches were detailed in most essentials but vague in the important one of directions. From the maps and documents investigated Mr. Hare has presented four valuable maps. The first, a map of the valley of Anahuac, he has prepared from historical sources. It gives a clear conception of the site of Tenochtitlán and the occupation of the valley around Lake Texcuco at the time of the Conquest. The other three are maps of the capital, dating from 1524 (the city before the Conquest), 1555 (the rebuilt city after the Conquest), and 1772. The second and third maps are not to scale but are considered trustworthy in their expression of relations. The series forms a living geographical background for the Aztec capital and provides a starting point for the study of the geography of Mexico City.

Sketches of Scenery and Vegetation in the Arid West

P. L. Monnet. **Explorations botaniques: La Californie et les grands déserts américains: Notes et études.** With a preface by Gaston Bonnier. 244 pp.; maps, ills., bibliogr. Librairie Générale de l'Enseignement, Paris, 1922. 12 fr. 9 x 6 inches.

This book consists of descriptions of topography, geology, and vegetation in parts of California, Nevada, and Arizona, with a narrative of the author's travels in these states during the year 1913 and lists of the plants collected in the several areas. The preface by Professor Bonnier informs us that Monnet, whose father was at that time French consul general at San Francisco, returned to France to join his artillery regiment at the outbreak of the Great War and was killed in action in October, 1915, when only 22 years old. The book was written during intervals of activity at the front and was left incomplete, the narrative terminating at the beginning of the author's journey across Death Valley.

The regions treated are: San Francisco Bay country, Oroville and Feather River, the Redwood Forests of Mendocino County, Honey Lake Valley, Surprise Valley and Warner Range, southwestern Nevada (the Goldfield region), the Gila desert of southwestern Arizona, and Death Valley, California.

The briefness of the young author's acquaintance with the country he explored and the conditions under which the book was prepared give it necessarily the character of a series of sketches. American readers having access to other sources

of information will probably find in its pages little that is new to science; but the vividness of the descriptions of scenery and vegetation and the excellence of the style will commend the book even to readers who know these regions well. The southwestern deserts and their vegetation are so graphically portrayed in words as to render almost superfluous the numerous fine reproductions of photographs illustrating the volume. Not the least attractive feature of the book is its revelation of the author's essential friendliness. He shows a keen and sympathetic interest in the often picturesque human types encountered in his wanderings.

One cannot read this book without being impressed with the keenness of observation and the vital interest in science possessed by the author. Geographical distribution and the structural adaptations of plants to their environment were his favorite subjects. The plant associations of the regions visited are described briefly but with a skill indicating that, but for his untimely death, Paul Louis Monnet would have attained eminence in his chosen field of plant geography.

F. V. Coville

The History of Iceland

Knut Gjerset. **History of Iceland.** vi and 482 pp.; map, index. The Macmillan Co., New York, 1924. $4.00. 9 x 6½ inches.

The history of so isolated and individual a country as Iceland can hardly fail to embrace matters of geographical interest. While Dr. Gjerset's volume has little direct concern with geography—there is a short section on climate and natural resources—it affords interesting side lights, especially on the reaction of population movement to physical and political circumstances.

It was isolation that early attracted a comparatively numerous population to the island. Population at the close of the period of colonization (874–930) is generally estimated at some 25,000, a quarter of the present-day population (94,679, census of 1920); and some place the figure much higher. Furthermore, this population was selected: it was the aristocracy of Norway and the western colonies that here sought refuge and freedom, whence the advanced status and the early flowering of literature in the "saga island." An estimate for the end of the eleventh century gives a population of 50,000; towards the end of the eighteenth century it was only 40,000. Not only did the permanently difficult conditions of life tend to keep down the population, but the island was periodically swept by natural calamities. Dr. Gjerset enumerates the series of calamities that took place in the fourteenth century (pp. 240–242) and again in the seventeenth and eighteenth centuries (pp. 320–323). "During this [eighteenth century] century," he quotes, "Iceland experienced forty-three years of distress due to cold winters, ice-floes, failures of fisheries, shipwrecks, inundations, volcanic eruptions, earthquakes, epidemics and contagious diseases among men and animals, which often came separately, but often in connection with and as a result of one another." In consequence "the plan was even considered of removing the entire population from Iceland and colonizing them on the heaths of Jutland." The population has always shown itself sensitive to economic relations with the outside, and these have been influenced by the political control. The bad years of the early fourteenth century were in a measure relieved by the flourishing trade with Norway and the development of the export trade in dried codfish. The disasters of the eighteenth century were not retrieved until the general revival of commerce after 1814. Economic and political conditions are also reflected in the modern emigration of the latter half of the last century. There is an interesting note on the Icelandic "colonies" of the United States. During the last decades political freedom, formally granted in 1918, and economic progress have transformed Iceland into a prosperous and progressive modern state.

The Tatar Republic

B. N. Vishnevski, edit. **Geograficheskoe Opisanie Tatarskoi S. S. Respubliki, Chast pervaya: Priroda kraya.** [**Geographical Description of the Tatar Republic, Part I: The Nature of the Country.**] 279 pp.; maps and charts. Kazan, 1921. 10½ x 7 inches.

This volume contains chapters by different authorities on the extent, geology, topography, soils, climate, vegetation, and wild animal life of the country. All these subjects are capably handled from the specialist's point of view and yet made intelligible to the average educated reader by adequate explanations of the geographical terminology and principles involved. A vocabulary of scientific terms has been appended, as well as comprehensive bibliographies.

The Tatar Republic, with its capital at Kazan, is one of the federated soviet states formed in 1920 on the territory of the former Russian Empire. It embraces the region surrounding the junction of the Volga and Kama Rivers, the valleys of which, naturally, constitute the predominant features of its relief. The rock strata have not undergone folding and the type chiefly found next the surface is the variegated marl composing the topmost layer of the Upper Paleozoic "Perm formation." The territory was also not subjected to glacial action; but the ice sheet approached sufficiently near it to produce important effects in the form of alluvial deposits in the river valleys and a thick precipitation of loess transported by winds from the moraines. A long desert-steppe period converted this surface into the fertile *chernozem* which still comprises more than a third of the soil of the region. Over large areas, however, the soil has been degraded through the invasion of oak, fir, and pine forests, made possible by the very formation of the black soil, as well as by the advent of a somewhat more humid climate. Professor Gordiagin's excellent study of these forest régimes and their struggle for domination forms a valuable contribution to botany and forestry. He concludes, also, that further extension of these forests at the expense of the steppe has, as in the case of the American prairies, been checked since early times through periodic firing of the dry grass by men.

More than half the open land has been brought under the plow, being devoted almost wholly to grain crops. While the soil has held up well under this unvaried cultivation, it has proved a highly undependable staple resource, owing to the extreme annual variations in spring rainfall. In 1921, for example, this was less than one-quarter of the normal amount. The remedy suggested for the resulting famines is an increased culture of the potato, which is much less affected by spring droughts.

Apart from the general excellence of this work as a piece of geographical description, it is of especial interest because of the similarity between the region dealt with and the prairie lands of the United States.

J. V. Fuller

Cyrenaica in Survey

Olinto Marinelli, edit. **La Cirenaica: Geografica, economica, politica.** xi and 270 pp.; maps, diagrs., ills. Antonio Vallardi, Milan, 1923. 10 x 7 inches.

Under the auspices of the Italian Touring Club and with the patronage of the Colonial Government a party of Italian scientists traversed the plateau lying between Benghazi and Derna, visiting El Merj, Marava, Slonta, Cyrene, El Jubba, Tolmeta, and Marsa Susa during the fortnight of April 12–27, 1920. The results of their observations are set forth in the series of monographs composing the volume under review, which gives a varied survey of a region hitherto very imperfectly known.

The first study is that of Giuseppe Stefanini on the geological structure of the region, supplemented by a detailed appendix and particularly by a table of the geology of Cyrenaica as compared with Algeria, Tunis, Tripoli, and Egypt; and illustrated by a geological sketch map 1:1,500,000. The general conditions of the relief are studied by the editor, with a sketch map and an appendix. Cyrenaica is divisible into a coastal plain (Sahel) of recent formation and a mountainous region (Jebel); and it is entirely calcareous, even the dunes being practically sandless.

Hydrography is studied by Leonardo Ricci with a sketch map. Apart from the *baltas*, or basins at an elevation of 150 meters on the southern borders of the pre-desert region, and the *sabkhas* ("salt lands"), or salt lagoons fed from the sea, south of Ghemines, as well as a number of ponds more or less permanent, there is a marked scarcity of surface water. Certain wadis are fed from springs, and there are numerous temporary streams; but all these are wholly inadequate for agricultural and other needs. All the wadis of Cyrenaica are short, the longest being probably the Wadi Derna (100 km.) and the most extensive basin (about 1100 sq. km.) being that of the Wadi El Kuf (65 km. in length). It is as yet difficult to trace the watersheds; and the effect of rainfall is still insufficiently known. Subterranean water certainly exists, though its volume is quite undetermined; and there are subterranean water caverns, as at Jok-Lete.

Climate is discussed by Ezio Mosna, at least as regards temperature, precipitation, and air currents; though data of value are recorded only for Benghazi, Derna, and Tobruk. In the cold (wet) season (October to March) the winds blow from the south, and from the north in the dry (hot) season (April to September). The mean winter temperature at Benghazi is 10° C., rising in summer to 30° and sometimes to 40°. The mean annual precipitation, which falls only in fixed periods, is less than 500 millimeters; so that Cyrenaica ranks as an arid region, though the plateau is less dry than the coast. There is, however, great variability in this regard, 617 millimeters being recorded for Benghazi in 1894 and only 137 in 1914. Rain is also brought by the west winds; but the hot, dry south winds of spring and autumn, usually beginning at evening and lasting several days, exercise an injurious effect on vegetation and animals alike. Acclimatization is easy, however, for southern Italians and Sicilians. The chapter is illustrated by a sketch map of precipitation and by charts of winds and rains at Benghazi and Derna.

The flora of Cyrenaica, which is discussed by Cesare Calciati, is less rich than that of Tunis and northern Algeria; it shares about 70 per cent of its non-endemic flora with Greece, 79 per cent with Tunis and Algeria, and only 52 per cent with Tripoli, the entire distribution being indicated by a sketch map. The author finds eight distinct zones of vegetation: (1) the desert, covered after heavy rains with brief-lived xerophilous growth; (2) the pre-desert; (3) the Sarval, about 65 kilometers square and less than 200 meters above sea level, well-watered, and producing barley; (4) the coastal plain; (5) the oasis of Derna (largely artificial); (6) the inland plateau; (7) the plain of El Merj (oats); and (8) the highland steppes. The fauna is studied by Alessandro Ghigi.

Notes on the ethnology of Cyrenaica are contributed by Francesco Béguinot. The ancient invaders—Phoenicians, Greeks, Vandals, and Byzantines—fused but little with the aborigines and penetrated scarcely beyond the coast line. The same statement holds true of the Arabs of the period of conquest in the middle of the seventh century; but a large minority (about one-third) of the Arabs of the period of invasion in the middle of the eleventh century were absorbed by the Berbers, though some small groups have preserved their ethnic unity. The Berber language, however, is spoken only in the Oasis of Augila by about 2000 persons; and there are but scanty traces of ancient traditions. Some stone implements have been found (cf. the appendix by Nello Puccioni).

Discussing the centers of population and the nomad tribes, we are informed by Ricci that there are but few towns, whether permanent or temporary—a condition which seems to have prevailed in antiquity as well. He estimates the population of ancient Cyrene (now Cirene) as between 20,000 and 25,000; of Apollonia (Marsa Susa) as 10,000; of Ptolemais (Tolmeta) as 8000; of Tauchira Arsinoe (Tochra) as 5000; of Berenice (Benghazi) as 5000; of the entire region as about 200,000. In 1817 only two centers were mentioned by Della Cella, Benghazi (5000) and Derna (500); but through the energy of the Senussi a marked revival began about 1840, and in the last decade of the nineteenth century the Turks encouraged immigration of Circassians, Kurds, and (especially) Mohammedan Candiots from Crete. Yet even now the country is occupied by nomads except for non-Arab and non-Berber elements; and the density of population, exclusive of the desert, is not even three per square kilometer (cf. the sketch map, 1:2,500,000, p. 103). Ricci estimates the population as 95,000 nomad and 50,000 sedentary, a total of 145,000.

The native system of agriculture is considered by Armando Maugini, its present condition by Antonio Belluci, and pasturage by G. L. Mainardi (pp. 135–142). The sedentary population is centered in the north, where no true nomadism exists; the seminomads sow grain wherever conditions permit (though these vary each year); and the nomads devote themselves to their flocks and herds, increasing the deforestation which is progressively injuring the land. The Mediterranean area might be made more and more agricultural, though the pre-desert zone must probably remain pastoral; but the backward character of the natives and their scanty needs and numbers (which are decreasing) form a grave barrier to any progress, to say nothing of the obstacles of native customs, particularly the quasi-communism of the Senussi and the system of land tenure (cf. Massimo Colucci's study of landed property in Cyrenaica, pp. 143–157). Furthermore, the evil heritage of the past is too great a burden to be speedily overcome; for it seems to be agreed that the decline of Cyrenaica from the prosperity which is attributed to it by classical writers is not due to diminution of rainfall or to deterioration of climate or to any other physical cause but to the historic factors of the fall of civilized alien rulers (notably the Greeks and Romans), invasions (such as those of the Vandals), and barbarous domination (as that of the Turks; cf. also pp. 46–48 and 167–171). Nevertheless, the Italian occupation, though dating only from 1911, while the Organic Law of Cyrenaica was promulgated only in 1919, has already brought some degree of amelioration.

The colonial problems of Cyrenaica are treated by Fabrizio Serra. He holds that a zone between sixteen and forty kilometers wide, extending from Tocra to Chersa and containing some 375,000 hectares, is ready for immediate agricultural use and that this area may easily be doubled. The communications now existing are listed. The chief immediate requisites are roads and ports (cf. Ermes D'Orlando's study on the port of Derna in the appendix); the necessity for a railway is not so clamant (the only one now existing is a narrow-gauge line of 35 kilometers from Benghazi to Regima); but when it is constructed, it should follow the southern limits of greatest production, thus being symmetrical with the coast from Benghazi to Derna. The chief difficulty is that of land tenure, though the problem is simplified by the Mohammedan law (taken over by the Italians) that the state enjoys the right of eminent domain. It should, therefore, be possible to make satisfactory arrangements with the natives if tact and justice are observed; and even the Senussi problem seems capable of equitable solution.

The volume contains two other studies of interest: Serra's monograph on the administrative system under the Turks and under the Italians and Pietro Vallardi's article on the school problem; but these fall outside the purview of the geographer. Only two matters seem to be missing: a brief survey of the history of Cyrenaica

and some account of its archeological remains; for though they are not required by the scheme of the expedition, they would have rounded out the work and made it a veritable encyclopedia of Cyrenaica. A bibliography would also have been welcome; but these are very minor objections in view of the excellence of the volume, which is concluded with a bathyorographical map (1: 1,000,000) of the region under consideration.

Louis H. Gray

The Climate of the Netherlands East Indies

C. Braak. **Het klimaat van Nederlandsch-Indië (The Climate of the Netherlands Indies).** With English summaries. Vol. 1, Part I, v and 63 (Dutch) and 18 (English) pp.; ills.; Part II, iii and pp. 65–147 (Dutch) and 19–50 (English); maps, diagrs., ills.; Part III, iii and pp. 149–221 (Dutch) and 51–90 (English); maps, diagrs.; Part IV, iii and pp. 223–278 (Dutch) and 91–122 (English); maps, diagrs., ills. *Kon. Magnet. en Meteorol. Observatorium te Batavia Verhandelingen No. 8.* Batavia, 1923. 11 x 8 inches.

The Dutch have made careful observations in the East Indies for many decades, and some of the world's most eminent meteorologists, including Bergsma, van Bemmelen and van der Stok, have shared in the investigations. Braak, therefore, has a good foundation upon which to build for his treatise which promises to be a thoroughgoing piece of work.

The preface announces three volumes, the first dealing with general features, the second with the local climates of the different islands or groups of islands, and the third containing the climatological tables. The present review concerns the first four parts of Volume 1. Forthcoming parts of this volume are to discuss temperature and humidity; dew and fog; thunder and lightning; hail; deviations and disturbances; and (Chapter 13) comparison of the climate with that of other regions.

If the high standard of excellency set by the four parts already received is maintained in the remaining parts, this treatise unquestionably will be recognized as one of the very best discussions of the climate of a region. The parts already issued form in themselves a reference work of great value. Furthermore, several of the descriptions of weather and climatic conditions are so well done in the English summaries as to merit becoming classic in scientific literature. The general descriptions in Chapter 3 are excellent. The importance of slight differences in temperature are pointed out, 21° C. (70° F.) being a stimulating temperature for persons accustomed to the 26° or 27° (80° F.) prevailing near sea level. An elevation of 1000 meters is preferred in Java to higher stations, which are often chilly and subject to uncomfortably marked variations in humidity and to cloudiness. Chapter 4, dealing with winds, discusses monsoons satisfactorily and includes accounts of several destructive tropical cyclones especially near Timor (latitude 7° to 10° S.). Squalls in which the wind velocity exceeds 40 miles an hour are rather common, and several whirlwinds closely resembling tornadoes are described. The chapter on rain includes six large rainfall maps and many data, as well as a good discussion of time and place distribution. Chapter 7, Cloudiness and Sunshine, forms Part IV. It includes a good discussion of causes of cloud formation, descriptions of clouds, vertical and regional contrasts in cloudiness and types of clouds, mist, the percentage of sunshine in different months and places, and some interesting facts on the intensity of light. Braak reports that in the lowlands sunlight is considerably less than at Washington, D. C. (with the sun at the same angle). At high elevations, however, it is notably more. As haziness rather than invisible vapor shuts out the light and as rainfall sweeps away the haziness, the curves of sunshine intensity are roughly parallel with the rainfall curves.

Stephen S. Visher

Two French Works on Weather Forecasting

J. Rouch. **L'Atmosphère et la prévision du temps.** 204 pp.; maps, diagrs., bibliogr. (Collection Armand Colin, No. 36.) Librairie Armand Colin, Paris, 1923. 5 fr. 6½ x 4½ inches.

Gabriel Guilbert. **La prévision scientifique du temps.** ix and 438 pp.; maps, diagrs., ills. Augustin Challamel, Paris, 1922. 10 x 6½ inches.

Captain Rouch of the French Navy was in charge of the meteorological services of both army and navy during the World War. His serviceable little book is written, as might be expected, from the viewpoint of a professional forecaster. There are no descriptions of instruments and but few directions for making observations. It is taken for granted that the reader is familiar with the basic laws of physics. Beginning with temperature, the author passes rapidly to pressure, hygrometry, insolation, cloudiness, and precipitation. In Part II the various chapters treat of the distribution of these elements; and then follow optical phenomena, cyclones, and anticyclones. In Part III the author speaks as one who has himself been actively engaged in the application of weather forecasts, short range and long range, for military purposes and also for agriculture.

He states that one of the first questions asked him when he became head of the meteorological service, was "What date had the least probability of rain?" The army chiefs were much concerned because the first battle of the Somme was impending. Records kept by the Messrs. Chandon brothers (1784–1869) at Montdidier, showed that on the 11th of August it had rained only 19 times, or 22 per cent of the total number of days. The dates with greatest probability of rain were September 23, when it rained 57 per cent of the time, September 22 and 24, October 8 and 18, and December 2, 4, 6, 17, and 27. The coincidence of the three rainy days with the autumnal equinox, is interesting. The spring equinox is not marked by any increase in rain frequency.

The author holds that we are not yet able to trace definite periodicities in the sequence of weather; and that, notwithstanding much that has been written and claimed, it is not easy to identify wet and dry periods. Even Brückner's 35-year period is regarded as of doubtful validity.

In the section on the application of meteorology to the military arts the author quotes the description of the battle of Waterloo from "Les Miserables:" "If it had not rained on the night of June 17, 1815, the future of Europe would have been changed. A few drops of rain mastered Napoleon. Because Waterloo was the finale of Austerlitz, Providence needed only a cloud crossing the sky, out of season, to cause the collapse of a world."

M. Guilbert in the preface to his work says that he wishes to give a résumé of his scientific activities covering forty years. He began in 1886 with a method of forecasting based solely on cloud formation and motion, amplified it in 1890 by a study of isobaric charts, and since 1891 followed what is known as a mixed method. The forecasts published in *Le Matin* daily, and more recently at noon by the Office National Météorologique, are based upon this combination method. The Guilbert method depends primarily upon observations of the wind. "The wind," our author says, "controls pressure and hence weather"—a view which orthodox aerographers consider heretical.

The author hits back at official forecasters by reminding them that the whole world knows that after sixty years of the weather map the forecasts are far from having a high degree of accuracy. His own predictions, based upon simultaneous study of the upper clouds and the surface conditions and certain rules, have a percentage of verification well above 80. However, in all this forecasting constant use is made of the synoptic map. What is known as the normal wind, that is a

wind where the velocity is directly proportional to the pressure gradient, is first determined. An excess abnormal wind indicates an approaching "high;" a minus abnormal a disappearing "low."

The first sixty pages are given up mainly to argument in defense of the twenty-five rules set forth in an earlier book, "Nouvelle Methode de Prévision du Temps," 1909, and reiterated in the body of this volume. Prominent French meteorologists have not hesitated to criticize these rules, and here our author in turn responds with true Gallic politeness.

Part III treats of clouds. There are some fairly good illustrations. A new name, *cirro-nimbus*, is introduced; but the illustration is suspiciously like cumulo-nimbus. Also the cloud generally called alto-cumulus now changes its name to *cirrus-moutonné;* and cirro-cumulus to *cirrus-pommelé*. A new classification is offered.

Much that follows is essentially controversial, the author criticizing pointedly the work of the Bureau Météorologique Militaire, and the successor of the Bureau Central Météorologique.

Alexander McAdie

A Memoir on Cloud Systems

P. Schereschewsky and P. Wehrlé. **Les systèmes nuageux.** Vol. 1, xvi and 77 pp., diagrs.; Vol. 2, maps; Vol. 3, photographs. *Mémorial de l'Office Natl. Météorol. de France*, Vol. 1, No. 1. L'Office Natl. Météorol. and Étienne Chiron, Paris, 1923. 12½ x 9½ inches.

The French Meteorological Office is the logical successor to the Bureau Météorologique Militaire; and in this the first year of its existence offers eleven memoirs, of which this work on clouds in three parts heads the list. Colonel Delcambre, the director of the new service, points out in the preface that a discussion of "noyaux de variations de pression" should have preceded this work on the clouds; but for various reasons the original plan could not be carried out, and so the clouds have priority. We lack an English word that will adequately translate "les noyaux de variations," and perhaps the meaning will be best brought out if we call these pressure pulses "action centers." We can do this more readily since the old "centers of action" have been replaced by "hyperbar" and "infrabar." These *noyaux* are determined not by the isobars on the synoptic map but by the isallobars and undoubtedly are of greater significance in forecasting than are the customary pressure areas.

In this work stress is laid upon the sequence of cloudiness with individual pressure distributions. Briefly, if the succession of cloud forms can be accurately forecast, then it is plain that accurate forecasts of the general weather will follow. The French and Norwegian methods of forecasting are thus somewhat alike; although the former give more weight to clouds and action centers, while the latter stress areas of discontinuity as in warm fronts and polar fronts.

In the second volume, or folder, there are thirty-three large sheets, on some of which there are as many as twelve weather charts (7.5 x 11 cms.). These maps show isobars, *noyaux*, and winds at 1000 meters with the cloud sequences.

The third volume contains 26 photogravures of cloud types, with copious notes describing the weather conditions. The photographs, however, are those of individual clouds and do not tell the whole story of the succession of clouds or even of the cloud formation in a different part of the sky. Plate 1, for example, is a beautiful cirrus on the front of a depression. This cirrus and another were the advance runners of a cloud train that crossed France from northwest to southeast on August 24, 25, and 26, 1902. A good example of mammato-cumulus is given on Plate 21. This

type, said to be rare in France, was part of a train of storm clouds crossing France June 26–30, 1917. At Paris the succession was cirrus, cirro-cumulus, cirro-stratus, alto-cumulus, then rain and low level clouds; heavy rain occurred before the appearance of the mammato-cumulus.

ALEXANDER MCADIE

PLEISTOCENE CHANGES IN THE BALTIC BASIN

WLADIMIR KÖPPEN. **Das System in den Bodenbewegungen und Klimawechseln des Quartärs im Ostseebecken.** *Zeitschr. für Gletscherkunde*, Vol. 12, 1922, pp. 97–123.

The late Pleistocene oscillations of level in northern Europe, with respect to the sea, are regarded as consequences of climatic changes related to variability in the ice load that the region had to support. Climatic evolution is considered as a consequence largely of changes in the position of the earth's poles. During the maximum of the last glaciation the north pole—according to this hypothesis—lay in Greenland. The low-pressure area which now lies at Iceland was then situated off the northwestern corner of Spain. The storm tracks now crossing Scandinavia then swept over the Mediterranean region, causing a pluvial period there. The loess may have been deposited essentially through the agency of the dry winds coming from the glacial anticyclone that is assumed to have lain over the ice sheet. The mechanism of the late Pleistocene changes of level, attributed to the loading and subsequent unloading of the ice, is treated at some length. Interestingly enough, substantially the same conclusions had already been reached by Swedish students. However, the described course of the oscillations is now out of date (see *Geogr. Rev.*, Vol. 12, 1922, pp. 602–612). The division of the Ice Age into four (or five) glacial periods may be due to cosmic periodicity through which the summer temperatures undergo considerable variations. According to M. Milankovitch's insolation curve the summer temperatures reached a minimum 25,000 years ago and a maximum 10,000 years ago. The greatest extension of the last glaciation coincided with the lowest summer temperatures, the postglacial temperature maximum with the highest. The disappearance of the last ice sheet may have begun some 25,000 years ago, but the postglacial temperature maximum prevailed from about 5500 to 2500 years ago, as shown by studies in Sweden. However, some 10,000 years ago the Scandinavian ice began to decay with catastrophic rapidity, indicating a marked increase in the summer temperature.

ERNST ANTEVS

MAN AS A GEOLOGICAL AGENT

R. L. SHERLOCK. **Man as a Geological Agent: An Account of His Action on Inanimate Nature.** With a Foreword by A. S. Woodward. 372 pp.; maps, diagrs., ills., bibliogr., index. H. F. & G. Witherby, London, 1922. 9 x 6 inches.

The author of this excellent work, using the British Isles as a type, has endeavored to show quantitatively the importance of man in modifying the surface of the earth. But he has not been content merely to estimate the quantity of material removed in the mining of coal and metalliferous ore, salt, oil shale, and excavations of other kinds, such as railroad cuts and fills. One finds under a discussion of roads, for example, a treatise on Roman roads, under coal and salt an essay on the prevention of subsidence. There are also brief histories of glass, of brick making, etc.

The discussion of denudation by excavation is necessarily largely a matter of statistics in which are computed the volume of rocks and ores taken out of the earth in mining and in the withdrawal of salt by solution. The total volume of rock excavated by man in Great Britain from various kinds of excavations is

estimated to be about 37,709,000,000 cubic yards. Denudation by attrition in roads and footpaths, in the manufacture of cement, lime, plaster of Paris, etc., is calculated to have been, in 1913, about 10,000,000 cubic yards.

An interesting chapter on subsidence due to mining and salt working considers the modification of the earth's surface which has resulted largely from the removal of salt in solution as brine. A striking example of the slowness of the natural denudation of salt as compared with its artificial removal is that of the salt mountain of Cardona, in Spain, which is said to waste, under atmospheric agents, by only four inches a century; whereas there is prospect that an area of some 200 square miles in Cheshire will in time be reduced by an average of 100 feet, which would bring much of the region below sea level.

The chapter on London is difficult for one not familiar with the city, but it is, nevertheless, a valuable study of the concentrated effect of man in changing an extensive marsh and mud-flat area into a well-drained one. The evidence indicates that the city has been raised by débris at the rate of about one foot a century.

Numerous examples of the delicate balance between erosion and deposition on the English coast are cited. The dredging out of flint pebbles, shingle, and clay ironstone concretions has caused changes in the ocean currents that have produced important modifications of the coast line. The building of dikes and the dumping of slag have caused the deposition of sediment and aggradation.

The discussion of changes of climate brought about by deforestation, by the increase in population, and by the increase in the carbon dioxide content of the air is not as convincing as other chapters.

The conclusions are that the geological effect of man's activity resembles that of a glacier more than that of any other natural agent. Morainic material bears some resemblance to the waste heaps left by man in mining and in manufacturing; eskers and kames bear a close resemblance in outward form to railroad fills; and artificial lakes to glacial lakes. Man's accomplishments are large as compared with the present work of erosion and weathering. Geikie estimated that the rate of erosion of the British Islands is equivalent to 2.72 inches in 2000 years, or less than half that due to man during the same period. In a densely populated country like England man is many times more powerful, as an agent of denudation, than all the atmospheric denuding agents combined.

Teachers of geology and geography will find in this book many interesting examples for classroom illustration.

Herdman F. Cleland

Human Culture

Clark Wissler. **Man and Culture.** xi and 371 pp.; maps, diagrs., ills., bibliogrs., index. (Crowell's Social Sci. Ser.) Thomas Y. Crowell Co., New York, 1923. 8 x 5½ inches.

There is no doubt that the intelligent world is at the moment keenly interested in human problems; it has reacted from the artificialities of politics and is seeking to appreciate the subtleties of man's real problems; it is turning from the quest for power and profit and demanding information about life. Wissler's book is one response to this demand, and Goldenweiser's recent one (Early Civilization, New York, 1922) is another. They are of special interest as contributions to knowledge based primarily upon American evidences, though both authors have read and observed widely. Goldenweiser seeks to expound the various aspects of life and treats in series environment, industry, art, religion, society, and mentality and so chooses his examples as to give, in all, a fairly comprehensive treatment of five groups, the Central Eskimo, the Tlingit and Haida of Northwestern America, the Iroquois Matriarchate, Uganda, and the Central Australians. Wissler follows a much more

generalized line of thought; he treats of the meaning, form, and content of culture, its universal pattern, it acquisition and diffusion, natural and organized, with examples of the most various peoples. His work and Goldenweiser's thus supplement each other with only minor overlaps. Wissler, moreover, is very clear as to the essential unity of the problem, whether we are dealing with nature folk or so-called civilized peoples; indeed he has many acute remarks on the spread of militarism and the tendency of "the flag" to follow trade which goes with culture diffusion and attendant disorganization.

One of Wissler's most fascinating chapters draws inferences from certain examples of culture spreads. Horse culture came to post-Columbian America mainly from Spain. It spread in America faster than did the Spaniards, and the horse ran wild; nevertheless the Indians everywhere adopted accessories based on Spanish patterns, associating therewith a few local details like the bolas of South America; and the cowboy of the western plains adopted many details that the Indians acquired from the Spaniards. But, though the Spaniard rarely made the horse drag a wheeled vehicle in America, the Indian unhitched the dog from his dray or travois and put the horse to this work. He fitted the horse into the frame of his own life but copied many details which came with the horse. The spread of maize shows us very different sequences. It was cultivated in olden time along the Atlantic seaboard and the Gulf Coast of what is now the United States, and thence westward to the Mississippi the maize complex, as Wissler calls it, is uniform in all essentials; he draws the conclusion that it must have spread complete. Europeans took over this culture but in spite of their traditions, copied many details from the natives, and, modified by mechanism it is true, those native traits remain with us still. We have here probably a case of delicate adjustment to environment, and environment has encouraged the maintenance of the old traits. But maize was also taken across to the Old World, and in Europe it was an isolated culture element introduced into a complex tradition so that the cultivation of this grain in the Old World took on traits from Old World agriculture. Here again environment modified the intruding culture. Wissler makes interesting efforts to describe culture complexes and to follow diffusion of their elements, diffusion in some cases in complete form, as we see in the case of maize, but more often with progressive impoverishment as we move out from the center. The culminating traits often enough do not travel far. Culture traits of America north of Mexico are parallel with culture traits in America southeast of Peru and suggest spread in both cases from a center somewhere within the Mexico-Peru belt.

Another of the author's points is that a more or less highland belt from the Pyrenees through Asia to Patagonia grades northward into plains whose limits are tundra and in the Old World southwards into jungle, the jungle in South America being on the eastern side instead. He notes that the dark-skinned peoples are characteristic of the jungle side, that the roundheads occupy the mesa, and that the longheads, with some roundheaded intrusions, occupy the plains towards the tundra. Higher traits of culture have tended to appear chiefly in the highland zone (he calls it the "mesa") and to spread outwards.

These illustrations will show the wide range and the great value of Wissler's little book. One could wish for adjustments here and there. For example he quotes Franz Boas' conclusions as to changes in bodily form of the descendants of immigrants into the United States, though a number of workers have shown fairly clearly that Boas' evidence in this case is quite inadequate and the analysis faulty.

Again, along with acute remarks on the weak points in Elliot Smith's theory ascribing the origins of the Maya civilization of Central America to immigrants from the Old World across the Pacific, he hardly refers to some curious parallelisms in detail between Old and New Worlds which as greatly need treatment by Americanists who believe in the independence of prehistoric American culture as the detailing of analyses needs treatment by Elliot Smith and his followers. It may be that American scientists

have settled to their satisfaction the interpretation of the curious representations which Elliot Smith has suggested are based on the elephant (*Nature*, London, Vol. 96, 1915–1916); but a number of their colleagues in the Old World, including some who are very critical of many details of the migrations doctrine, would like to see this matter faced—as well as others. The fascinating and important chapter "The Domestication of Man" has interesting thoughts but is disappointing; the student should refer to the late Giuffrida-Ruggeri's "La domesticita dell' homo" in his last work "Su l'origine dell' uomo" (1921)—a book too little known among students of mankind.

H. J. Fleure

Our Daily Bread: The World Production of Food Crops

Gunnar Andersson. **Vårt dagliga bröd: Näringsväxterna i världsproduktionen.** viii and 230 pp.; maps, diagrs., ills., index. Hugo Gebers, Stockholm. 8 x 5½ inches.

"The Geography of Foodstuffs" epitomizes the message of this book. The author presents his subject in bold outline and carries his readers with swift and impressive strokes through the natural controls of plant growth to the importance of food plants in national life. There are only eight chapters, but their headings indicate that each is a thesis in itself, viz.: "Why Plants Gather Nourishment and Why We Eat Them," "What Plants Eat," "How Cultivated Plants Originated," "The World's Great Granaries," "The Importance of the Tropics in World Food Production," "Vegetable Fats as Foods," "Needs of the Swedish People in Foodstuffs," and "Future Swedish Foodstuffs Policies."

The chapter headings indicate the scope of the book. The early part of the work lays much emphasis on the botanical relations of food plants and presents a clear philosophic discussion of how early man must have blindly experimented in the selection and cultivation of the food plants that he found most desirable. Thus the debt of modern food-plant agriculture to the slow evolutionary progress of the ancients is pointed out.

In Chapter 4, "The World's Great Granaries," attention is directed to the increasing demand for foodstuffs in the world that comes with increasing population and the rising standards of living. Wheat production receives major consideration, with Indian corn (maize) second. A commendable summary study of the wheat industry of the United States, Siberia, and Argentina is here presented. Canada receives perhaps less attention than the wheat industry of that country merits, but this can readily be explained by the youth of the industry there when compared with the older regions mentioned.

The treatment of tropical foodstuffs, while necessarily brief, is gratifying in that emphasis is given to the relationship of production to altitude and rainfall. Thus the picture of diversity of products is well painted. The importance of the tropical regions is clearly demonstrated; but extravagant claims, such as often characterize publications of those who have not visited this part of the world, are refreshingly absent.

The two closing chapters deal directly with Sweden's food problem. The importance not only of the supply but of its relation to national economic and political questions is carefully presented. The emphasis here given was perhaps inspired by the trying times of the Great War. As a whole the book is a worthy and interesting discussion of the relation of food plants to natural environment and to national welfare.

Nels A. Bengtson

CORRESPONDENCE

On River Meanders

Vienna, January 14, 1924

To the Editor of the *Geographical Review:*

In the October, 1923, number of the *Geographical Review* (pp. 629–630) Mr. W. M. Davis has rather severely criticized my studies on river meanders.

Geographers and physicists sometimes have difficulty in understanding one another. A physicist who tries to apply a physical principle to a certain natural phenomenon or performs an experiment to explain it cannot expect to reproduce the phenomenon exactly. He only hopes to find out whether his theory can be applied in its essentials and whether or not his experiment gives the intrinsic process. The geographer who compares the mathematical formula or experiment with the natural phenomenon is mistaken if he thinks that such investigation of the process is of no value unless full agreement is obtained.

In the theoretical parts of my paper "Zur Theorie der Flussmäander" (*Sitzungsber. Akad. der Wiss. in Wien, Mathem.-naturw. Klasse*, Vol. 128, 1919, pp. 1453–1473) I treated the following subject: What is the reason for the formation of meanders, and how is their size related to the dimensions and velocity of the river? The oscillation formula which I gave is as simple as possible, and I stated that the formula only holds good for meanders whose amplitudes are small compared with their wave length. Therefore one cannot expect the formula to give all the natural phenomena, e. g. the cut-off of meanders.

The criticism that I took the oscillatory rolling of a ball in a trough of concave cross section as fully analogous to the oscillatory flow of a river is unjustified. I spoke of this movement of the ball at the beginning of my paper to explain the double motion of oscillation and flow. I used the formula for the seiches of water, i. e. I did not confuse the dynamics of a rolling ball with the hydrodynamics.

In the experiment for producing meanders I had to introduce a strong external cause to produce the first flexure of the river. I could not wait an indefinitely long time until accidental irregularities in the material of the river bed should produce a curvature, as is the case in nature. I therefore introduced the water from one side into the rectilineal river bed. It was and is evident that the curvature opposite the inflow could not displace itself down stream but was forced to remain in its original position. Mr. Davis finds this experimental condition erroneous. I can only say that a simple experiment is better than none.

The experiment showed quite clearly that the wave length of meanders increases with their amplitude in agreement with the theory. If this proportionality is not always to be found in nature the reason is that only high water can change the river bed essentially. Low water will keep the existing curvatures and will only slowly excavate the concave river sides.

Mr. Davis adds a criticism about a second paper of mine, "Uber Schuttböschungen und Bergformen" (*Geografiska Annaler*, Vol. 5, 1923, pp. 59–71). It was the purpose of this paper to show how the slope angle of a sand slope depends upon the radius of the curvature of the slope in a horizontal plain. I had no wish to give a dynamical explanation for the formation of the slope, but only to find the conditions for stable equilibrium. The experimental representation of forms of sand slopes in this paper was intended to show their similarity with natural mountain forms, not to explain the formation of meanders in a valley. Regarding the ironical remark of Mr. Davis about the rounding of the upper contour lines of a hill, I am sorry that he does not perceive the difference between vague and general knowledge and mathematical expressions which give quantitative results.

Felix M. Exner

Washington, March 1, 1924

To the Editor of the *Geographical Review:*

In comment upon Professor Exner's letter, I believe that the seiche formula for lakes applies very imperfectly to river meanders; for, while it may by analogy give an approximation to the transverse component of a moderately meandering river, its homological incompetence is shown by its "only holding good for meanders whose amplitudes are small compared with their wave lengths." A competent theory should hold good for meanders whose amplitude has grown to be as great as or even twice as great as their wave length, or the double distance between successive "crossings," as river pilots call the points of inflexion. Further, an experiment which shows "quite clearly that the wave length of [artificial] meanders increases with their amplitude" thereby shows also that the experiment with the artificial stream as well as the theory which the experiment illustrates cannot properly represent true river meanders; for one of the most striking features of true meanders is that their wave length remains almost constant while their amplitude increases many fold; in other words, that the down-valley distance between successive points of inflexion hardly changes at all, while the right and left curves increase very greatly in radius and arc and hence in amplitude also, even to the point of producing cut-offs. Cut-offs are quite as characteristic features of fully developed meanders as small-amplitude curves are of incipient meanders; hence a meander theory that does not take account of curves increasing up to the point of cut-offs is seriously defective. One need not expect a correct theory to explain accidental irregularities of river flow; but, if a meander theory fails to account for features so systematic and essential as curves growing till they cause cut-offs, it cannot be accepted as correct. The reason that the proportionality between wave length and amplitude of meanders is not always maintained in nature is *not* "that only high water can change the river bed essentially" but that, even at high water, the change of channel at points of inflexion is slow and small, while the increase of radius and arc in the right and left curves is rapid and large. Moreover, the small change at points of inflexion is a down-valley shift by about the same measure at successive points; hence, in spite of such change the distance between those points, or the half wave length, remains essentially constant, while the meander curves go on increasing in radius, arc, and amplitude until a cut-off occurs. Finally this constancy of meander wave length shows that the oscillatory rolling of a ball down an inclined trough of concave cross section does not provide a satisfactory analogy with a meandering river; for, when the ball passes a point of inflexion in its curved path, it is experiencing a down-valley acceleration as strong as at every other point, and the wave length of its path therefore increases properly enough; but when a meandering river passes a point of inflexion, it has no *down-valley* acceleration at all, but only a *down-stream* acceleration; hence its wave length does *not* increase. In meanders of greater arc than 180° the down-stream acceleration at the inflexion points may even be directed obliquely *up-valley;* but the wave length of such meanders is not shortened any more than the wave length of more open meanders is lengthened.

W. M. Davis

Aberystwyth, April 19, 1924

To the Editor of the *Geographical Review:*

The reviewer of Dixon's "Racial History of Man" in the April number of the *Geographical Review* (pp. 334–336) wishes to acknowledge an oversight in his review. He had not found Professor Dixon's reference to the probable dominance of brachycephaly which occurs on page 512 of the book.

H. J. Fleure

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THE MARITIME AND RURAL LIFE OF NORWAY

By CAMILLE VALLAUX

Norway is known to all as one of the most picturesque of countries. A mountain fringe of ancient rocks, cut by deep depressions and half drowned in the waters of the North Atlantic, the first characteristic it offers to the traveler is the extraordinarily articulated coast, with a length of 17,000 kilometers where the distance in unbroken line is barely 3000, and the extraordinary number of isles and islets, 150,000 say the Norwegians. The isles and the tortuous channels that separate them from the mainland constitute the *skjærgaard*, the skerry guard. To the south and again in the extreme north the uplands of the interior stretch in broad plateaus, fjelds, ranging from 500 to 1500 meters in average height and terminating at the coast in abrupt cornices. In and northward from the center, in Romsdal, Lyngenfjord, and the Lofoten Islands the mountains, rising to about the same altitudes, present alpine forms. Both alpine mountains and plateaus are fragmented by deep fiords, narrow and winding, which penetrate to the heart of the massifs where the sea waters are imprisoned as it were between two walls. The Sognefjord, for instance, is 1244 meters (4081 feet) deep and penetrates 145 kilometers (90 miles) into the interior. Along the seacoast and up the fiords the precipitous walls of the fjelds and the Norwegian Alps are in places bordered at water level by a sort of bench, forming a series of little discontinuous coastal plains. Here live the farming and fishing folk of the fiords. To the southeast the country of the fjeld sinks, opening into broad valleys with forest-covered slopes; these valleys converge on Christiania, the capital of the country.

At sea level and in the lower regions the country is almost everywhere open to the tempering influence of the rains and mists of the Atlantic. At the same time, as it extends over 13 degrees of latitude—from 58° N. to 71° N.—there are pronounced differences of climate and vegetation between north and south. The south with its wheat fields and forests of oak and beech mixed with conifers pertains to central Europe; the north, with

FIG. 1—Sketch map to show the Norwegian localities mentioned in the text. Scale 1:12,000,000. See also for the areas shown in the maps of population distribution, Figure 2.

Fig. 2—Reproduction on a reduced scale (1:1,900,000) of typical portions of the population distribution map of Norway by Alfred Söderlund discussed by Mark Jefferson in this number of the *Geographical Review* (pp. 651–652). The land is distinguished by the darker tint (yellow in the original): see also Figure 1. The small black dots represent each 100 people; the "spheres," towns of over 3000 people; the small circles, the seasonal population movement for the sea fisheries.

soil of frost-splintered stones, with mosses, lichens, willows, and dwarf birch, is an arctic land. In the intermediate region the great variety of transitional forms is rendered more pronounced by the seasonal prolongation of days and nights and the increasing obliquity of the sun's rays which makes of arctic Norway a country of marvelous play of light and shade. Everywhere abound the waters derived from the Atlantic vapors, in the form of snow fields and glaciers on the domed heights of the fjelds and in the depressions of the alpine crests; as cascades tumbling down the abrupt sides of the fiords; as lakes and glacial torrents in the maze of narrow valleys which open into the fiords of the Atlantic and Arctic Oceans or in the broader valleys converging in the southeast toward the Skagerrak.

The Norwegian People

The harsh and inclement soil of Norway supports a small enough population—only two and a half millions on 125,000 square miles. It is not surprising: here man has three enemies—barren rock, high altitude, northerly latitude. But the people are robust, remarkable alike for tenacity and patience and cohesiveness. These qualities have triumphed over natural obstacles: the Norwegians have succeeded in combining into a national body the small groups scattered over a vast area and separated from one another by ice, mountain, or sea. On the western coasts in the Middle Ages lived the hardy seamen and pirates, the Vikings, that carried terror to all the shores of Europe. On the plains of Trondhjem arose the confederations of *bönder;* and here in the eleventh century, under the chieftain known as Saint Olaf, the chief force of the country was concentrated. From Stavanger to Aalesund and from Trondhjem to Christiania the clans of the Vikings and the tribes of the *bönder* were united, and Norway came into existence—that is nearly nine centuries ago.

Her people, it is true, have known long periods of submergence. The fiord dwellers of the west were reduced to a state of economic bondage by the Germans of the Hanseatic League; for four centuries Norway was a political dependency of Denmark; in 1814, though she acquired autonomy, she was compelled to accept a dynastic union with Sweden. It was only in 1905 that the last bond was broken and Norway regained the absolute independence she had enjoyed in medieval times. Her people—farmers, sailors, artisans, animated by a truly democratic spirit—hold an honorable position in modern civilization. Yet the country has not renounced the old traditions; on the contrary she clings to the most ancient of them with singular persistence. Especially among the farming folk one sees an active attachment to the past associated with a characteristic individualism.

Along the Fiords and on the Fjeld

Let us follow the shores of the fiords on one of the little mail steamers that may be met with almost anywhere. Where the fiord walls sink to

FIG. 3

FIG. 4

FIG. 5

FIGS. 3, 4, and 5—Fishing villages of northern Norway. Figure 3, Bergsfjord, latitude 70° N., has about 200 inhabitants and electric light, telephone, and telegraph. Figure 4 is Kjöllefjord, east of North Cape. Figure 5 is Skærvöy, latitude 69° 50′ N. (Photographs by H. P. Ulich.)

a coastal bench one sees meadows, fields, and houses built of wood and often painted in brilliant colors and always standing alone. These are the *gaards*, the estates of the peasant proprietors. The *gaards* are never in groups: often on a strip of plain, quite unconnected with the rest of the world, will be seen a single *gaard*. At long intervals rise church and bell tower, equally isolated; and here before your eyes is the center of a rural

Fig. 6—Bakke, near Gudvangen, Næröfjord.

community, *herred*, the political and social bond between the *gaards* separated from one another by rock walls and arms of the sea. In all Norway there are but 640 *herreder;* hence you may gauge the extensive area of these rural communities.

Two questions naturally arise: how do the inhabitants of the *gaards* gain a livelihood, and how do they communicate with their neighbors, the nearest of whom are often far distant?

Around the *gaards* are small fields, carefully tilled, growing a little wheat in the extreme south but chiefly rye, oats, barley, and potatoes, and for cattle fodder a crop of turnips. In many fiord valleys the chief cultivation is a mixed crop of barley and oats (*blandkorn*). On the warmer slopes of the south and especially in the more genial climate of Hardangerfjord, the sun-

niest part of Norway, cherries, apples, and pears flourish; farther north, as far as Trondhjem, gooseberries are an important crop.

Although such exploitation of the soil is a real triumph of ingenuity and patience, it does not suffice to support the population, small as it is. As one travels northwards vegetables, grains, and fruits dwindle in size, and their production is small. In Norway the area under food crops represents only a

FIG. 7—Sognefjord. (Photograph by H. P. Ulich.)

small fraction of the land, hardly a hundred-and-forty-fourth part; and it is impossible to increase this proportion. As a matter of fact the farmers of the fiords, like the fishermen, live largely on fish. For the most part, however, they do not make the catch themselves, for the waters of the fiords are not well stocked. Fish must be bought, and cattle serve as the medium of exchange. His cattle mean far more to the Norwegian farmer than his crops. The cultivated part of his farm (*indmark*) is of limited extent; in contrast his pasture (*udmark*) is practically limitless: it includes immense stretches of fjeld where the cattle are grazed in the summer. The fjeld is the Norwegian alp: it has its summer chalets, the *sæter*.

The life of the *sæter* lasts during the two or three months of summer in the great fjelds of the southern region (between Christiania, Bergen, and Trond-

hjem) from 200 to 600 meters in altitude. Then the fjeld is occupied by cattle grazing in complete liberty. At the end of the season descent is made to the *gaards* for the long and trying winter season, trying because the scant resources of hay and root crops do not always suffice the need, especially in the north. Should these resources fail recourse is had to fish offal, the herring of Romsdal or the cod of the Lofoten Islands. The cattle accommodate themselves very well to this kind of food—a strange thing in herbivorous animals.

On the fjelds of Nordland and in the extreme north the pastoral life of the Norwegian farmer and his cattle is of little moment. From the latitude of Trondhjem northward the country is largely occupied by the Lapps and their herds of reindeer. These curious nomadic people and curious arctic animals range from Norway through Sweden into Finland: Lapland with its indefinite limits stretching over the boreal zone of these three countries.

The Norwegian farmer of the *gaards*, in spite of the immense stretches of the *udmark* where he pastures his cattle, would seem to lead an isolated life—a fact reflected in a way in his taciturnity and reserve and also in his repugnance to any form of co-operation. Yet, isolated as he is, he is not a savage; and indeed the physical isolation is not so great as one might at first sight imagine. The lowland strips along the shores and narrow valleys sprinkled with *gaards* are often in communication by narrow open passes (*eide*) over the fjelds: of glacial origin, these passes are well adapted to the establishment of roads. Telephone wires run the length of the fiord and across the fjeld from *gaard* to *gaard* and even from *sæter* to *sæter*, and the fiord itself is a highway open to the possessor of a boat. During the year traveling schools go from farm to farm to give instruction to a people avid of learning. Physicians also make tours of their communes for the spread of hygienic knowledge; and the telephone and the telegraph make it possible to call the doctor in good season to the bedside of the patient even in the most distant *gaards*.

The great valleys and forests through the whole southeastern part of Norway where the valleys, roads, and railways converge toward the Christiania Fjord, Gudbrandsdal, Hallingdal, and the lake-filled valleys of Telemark, the physical isolation of the Norwegian peasants becomes less marked. The *gaards* approach one another and form groups; cultivable lands are more extensive and follow one after the other, no longer separated by masses of barren rock but by vast and magnificent forests that are among the most beautiful in Europe. These southeastern valleys are preëminently the domain of the peasant aristocracy, the *bönder*, which actually governs the country; their forests are one of the principal sources of wealth of all Norway.

The forests for the most part are masses of evergreen, Scotch fir and Norway spruce, the uniform tones of which are happily brightened here and there by the silvery flashes of the birch. They cover no less than 70,000 square kilometers, or more than a fifth of the total surface of the country. Although the forests belong to the state or to individual Norwegians and

form an essential element among the resources of the nation, the lumbermen are not all Norwegians. Quite often, especially in the immense forests along the Swedish frontier, they are of the Finnish race, descendants of Finnish immigrants of the seventeenth century. If we consider this in connection with the occupation by the Lapps of the great fjelds of the north, we may understand the truth expressed in the official account published on the occasion of the Paris Exposition of 1900 to the effect that "the Norwegians are a coast people and to a certain extent a valley people." Indeed they prefer not to live anywhere else.

FIG. 8

FIG. 9

FIGS. 8 and 9—Examples of the *stabbur*, barn granary, in Telemark.

There are those, however, who profit by the trade at the lumber-exporting wharfs (*ladesteder*), the chief of which are round Christiania—Skien, Fredrikstad, and particularly Drammen. Some 400,000 cubic meters of rough or half-finished lumber are exported annually, and also 350,000 cubic meters of pulp wood and cellulose. The wood industries are very prosperous as they are favored by the abundance of water power, and since the development of hydro-electricity sawmills and pulp works have multiplied greatly. Today exploitation of the forests is arousing from economic torpor the old province of Nordland between Trondhjem and Bodö. Its splendid forests have been little utilized up to the present. Exploitation, however, will come when the railway system, which now terminates a little to the north of Trondhjem, is extended to Bodö, well beyond the arctic circle.

Sea Fisheries of the Skerry Guard

On the coasts of Norway there is no clearly defined line between farmer and fisherman. The farmer has his boat and fishes when he has the op-

Fig. 10

Fig. 11

Fig. 12

Fig. 10—Henningsvær, a fishery station in the Lofotens.
Fig. 11—Another view of Henningsvær.
Fig. 12—Hammerfest.

portunity; he catches salmon in the fiords and sets his herring nets at the entry of the narrow tidal channels. The fisherman tends the little fields about his *gaard* even on the rocky islets, scant of soil and exposed to the high winds from the sea; invariably he has some pasture land and at least one or two cows. As the most productive fishing takes place in the winter, the fishermen find time to work on the land in spring and summer. But this combination of occupations is realized in full only as far north as the latitude of Trondhjem. Beyond that as one proceeds northward the land becomes hostile to all cultivation, and man looks for his support to the sea. Furthermore, it is in the subarctic and arctic zones that the fisheries are most fruitful. Eighty per cent of the entire catch of the Norwegian coast is taken north of Cape Stat.

The fisheries of the skerry guard are classed as daily and seasonal. The former furnish fresh fish daily to the markets of the coast towns. Bergen possesses the most famous and most interesting of these markets where from the fishponds of sea water constantly renewed the buyers can choose haddock, redfish, mackerel, turbots, conger eels, and also crustaceans (lobsters and prawns), which the waters of the continental shelf and the sounds yield in abundance. Every Norwegian port has its quays and fishing

basins where boats with and without decks rock on the waves and where the movement of coming and going, the discharge, sale, and despatch of fish testify to the importance of the industry. The coast towns, Stavanger, Bergen, Christiansund, Aalesund, Trondhjem, have each its fishery quarter and its fishermen, as do the towns of the Mediterranean, and are as rich in color and life as are they.

The seasonal fisheries from the south of Norway to the north of Trondhjem include chiefly those of the sprat, a sort of large sardine, and the herring. The sprat fishery takes place in winter, that of the herring in summer. Nets of different types are used for both. In the case of the herring extraordinary catches are sometimes made at the entrance of the tidal channels, which constitute a kind of trap. The catch is in large part destined for export, and there are curing and canning establishments at many points of the coast, notably at Stavanger and Aalesund. Salted herring is the chief export.

Although the fishermen are no more predisposed to co-operation than the farmers, it has in some measure been forced on them by the nature of their calling and by desire to increase the yield of the fisheries. They have especially profited by the admirable work of the Norwegian oceanographers B. Helland Hansen, Michael Sars, and Johann Hjort on the physics and

FIG. 13

FIG. 14

FIG. 15

FIG. 13—Encampment of Lapps near Lyngen.
FIG. 14—Glaciers of Lyngenfjord.
FIG. 15—Glacier of Svartis.

biology of the sea. Equipment also has been modernized. For all kinds of fishing, use of motor boats has increased enormously in recent years: in 1914 there were only 209 such boats; at the end of 1922 they numbered 1503.

The Cod Fisheries of the Lofotens and Finmark

Of the seasonal fisheries much the most flourishing and important in general trade is the cod fishery of the waters of the Vestfjord to the south of the Lofotens and on the coast of Finmark.

At the foot of the snow-covered crests of the Lofotens are the wooden wharves of some forty fishing stations (*fiskever*), of which Svolvær is the chief. Hither at the end of winter, from February to March, assembles a flotilla of fishing boats and cargo boats, the former to make the catch, the latter to carry it away. At that season the cod shoal in the waters of Vestfjord and draw fishers from afar, from all the coasts and interior of Norway and even from Swedish Lapland. To the number of eleven or twelve thousand, not including the women and children, they establish themselves in the fishing stations, taking up their quarters in the *rorböder*, great wooden sheds. Thence they set out each morning, with motor boat, sailboat, or even rowboat to fish for cod all along the Vestfjord. Equipment is as varied as the boats—bottom nets, bottom lines, ordinary lines with sinkers.

The fish are prepared for exportation on the spot: this explains the presence of women and children. There are two types of preparation. Stockfish (*törfisk*) is made by removing the heads and entrails and drying the fish on wooden platforms. The preparation of *klipfisk*, which is held in greater esteem and has a higher market value, is somewhat more elaborate. The initial stage is the same as that of the stockfish; then the fish are salted in the shed and dried in the open air on the flat or slightly rounded rocks that form the shore of the Lofotens. Fish thus prepared are exported all over the world. The production of the fisheries of the Vestfjord for these two months is valued at an annual figure of from fifteen to twenty million gold francs.

As April approaches the cod begin to leave the waters of Vestfjord and appear in increasing numbers off the shores of Tromsö and Finmark whither they pursue a small fish, the capelin, then abundant in these waters and their chief prey. Now the fishing season of Finmark begins and is prosecuted with great profit up to July. Tromsö and Hammerfest are the chief stations for this industry.

Distant Fisheries and Ocean Trade

Although the resources of their own seas are so rich and so varied, they do not satisfy the Norwegian fishermen, who seek more distant fields and a larger prize. They have long found profit in the whaling industry, and to its perfecting they have made notable contributions. It was a Nor-

wegian, Svend Foyn of Tönsberg, that in 1868 invented the harpoon gun, today in use on all whaling vessels. Formerly the Norwegians exploited the Arctic seas as far as Spitsbergen, now recognized as a political dependency of Norway; but since the beginning of the century they have abandoned these regions, at least temporarily, for whales have here become scarce. Today it is off the coasts of equatorial Africa and in the southern Atlantic that the Norwegian whalers pursue their laborious but lucrative calling. Steamships of five hundred to six hundred tons outfitted at Tönsberg, Larvik, and Sandefjord in the environs of Christiania are generally employed in the industry.

Seal hunting and walrus hunting are still conducted in the waters of Iceland and Spitsbergen by means of motor boats of eighty to one hundred tons outfitted at various west coast ports, notably Aalesund, Tromsö, and Hammerfest.

A numerous and hardy marine, experience in the hunting and fishing of all kinds of sea animals, timber in abundance for the building of boats as well as for export—these are the chief elements whence has developed the great maritime commerce of Norway. In spite of the competition of other forms of industry it still remains the principal and most flourishing feature of the economic life of the country. Its vitality is proved by the way in which equipment has been modernized and the extent to which steel ships and motor power have increasingly replaced the old sailing ships. The mercantile marine has rapidly made good the losses sustained during the war—976,000 tons, more than that of any other nation except England. With its 2,630,000 tons, of which nine-tenths are under steam, Norwegian shipping holds third rank in Europe.

The great shipping towns are Christiania and Bergen. Christiania holds first rank for port movement, Bergen first for tonnage of vessels belonging to its outfitters. But the maritime activity of the country is not limited to these two towns; it is dispersed all along the coast from Christiania to Trondhjem. Every port has its share; all are active and flourishing.

The Future: Industry and Labor

By virtue of her products of forest and sea Norway has long enjoyed a measure of industrial activity: lumber has been worked by water-driven sawmills; oil, codliver oil, and guano have been extracted from fish and exported from several places, especially Svolvær and Bergen. But it is hydro-electric power that has given rise to the present industrial development of the country. Though raw materials are not abundant—there is only a little iron and copper—the resources of hydro-electric energy are so great and so easily put to service that several large industrial plants have been established. Falls already harnessed give 1,630,000 horse power, and potential power is reckoned at 12,000,000 horse power. The chief plants, those at Notodden, at Rjukan, and at Odde in southern Norway, are devoted to

the production of industrial nitrogen, calcium carbide, and nitrogenous fertilizers.

This large-scale industry has created in a country of fishermen, sailors, and farmers an artisan class whose numbers are rapidly growing and growing especially at the expense of maritime industry. Here the numbers are diminishing especially in the ruder branches, such as the winter fisheries. The farmer class does not diminish. Fifteen years ago maritime industry occupied 158,000 workers: it now counts only 109,000 (against 650,000 on the land). The figures indicate a movement of social evolution destined without doubt to change in some measure the physiognomy of picturesque old Norway.

AVALANCHES

By André Allix
Institut de Géographie Alpine, Grenoble

At the end of December, 1923, the occurrence of a great number of avalanches brought much suffering and inconvenience to the high valleys of the French Alps. In Oisans and Briançonnais many roads and railways were cut. In Upper Tarentaise an entire village was engulfed, and several persons and all the cattle were lost.[1] In Upper Maurienne the highest villages were cut off from all outside communication for five days; they had no post, no bread, no telephone, no electricity. On the roads and in the châlets isolated men were overwhelmed. The international route from France to Italy by Maurienne and the Mt. Cenis tunnel was cut and also the lines to Chamonix and Bourg St. Maurice. The total losses in the French Alps alone in the last week of 1923 may be put at some 14 human lives and nearly a million francs.

Now these catastrophes are in no way exceptional. They occur many times during the winter in the alpine regions. Each mountain massif has its ravines down which avalanches descend every year. It is only the size of the avalanches that varies; in normal years they are generally limited and do little damage; exceptionally one or more assume catastrophic dimensions. In the same winter in the same valley there may occur simultaneously both small and large avalanches. The frequency and periodicity of avalanches and the permanent menace which they present in the mountains are sufficient reason why this phenomenon has been well studied in the mountainous regions of Europe.

Studies on Avalanches

On the subject of avalanches there are no less than 50 recent works worthy of note; 17 are French, 11 Swiss, 11 German or Austrian, 8 Italian, 3 Scottish. With the exception of the fundamental works of Coaz and Heim, both Swiss, they date back less than 20 years. The greatest part of this literature is due to alpinists and ski runners, the people who have the greatest reason to fear avalanches and who have the best opportunities for direct observation.[2] Then come the studies made in Switzerland and France

[1] F. Gex: Les avalanches de fin décembre 1923 en Savoie, *Rev. de Géogr. Alpine*, Vol. 12, 1924, pp. 129–155.

[2] W. W. Naismith: Snowcraft in Scotland, *Scottish Mountaineering Club Journ.*, Vol. 2, 1892–93, pp. 157–167.

F. W. Sprecher: Grundlawinenstudien, *Jahrbuch Schweizer Alpenclub*, Vol. 35, 1899, pp. 268–292; Vol. 37, 1901, pp. 219–243.

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Josef Müller and A. von Radio-Radiis: Gefahren des Schneeschuhlaufes in den Hochalpen, *Mitt. Deutsch. und Oest. Alpenvereins*, Vol. 30, 1904, pp. 8–9 and 17–18.

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by members of the Forest Service. The work of Dr. Coaz, former director of the Swiss Service of Waters and Forests[3] still remains at the head of this category; but the French foresters have lately made some notable additions to the literature of the subject.[4]

More recently geographers and glaciologists have been responsible for valuable contributions.[5] To these three distinct categories of scientific studies on avalanches must be added numerous descriptive and popular articles among which much useful information is to be found.[6] It should, however, be observed that several of the first category and many of the other categories derive from a common source; they are descendants of

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Adolfo Hess: Le valanghe, *Riv. Mensile Club Alpino Italiano*, Vol. 35, 1916, pp. 302–317.

Fritz Rutgers: Die Lawinengefahr für Touristen, *Ratgeber für Bergsteiger*, Vol. 1, 1916, pp. 98–133, herausgegeben von der Sektion "Uto," Schweizer Alpenclub, Zürich.

Max Oechslin: Ein Beitrag zur Kenntnis der Lawinen, *Alpina: Mitt. Schweizer Alpenclub*, Vol. 31, 1923, pp. 303–312.

[3] J. Coaz: Die Lawinen der Schweizeralpen, 2nd edit., Berne, 1881.

Idem, Die Lawinenschaden im Schweizerischen Hochgebirge im Winter und Frühjahr 1887–1888, Berne, 1889.

Idem, Statistik und Verbau der Lawinen in den Schweizeralpen, Berne, 1910.

[4] V. Hulin: Les avalanches, *Ann. Soc. des Touristes du Dauphiné*, Grenoble, Vol. 37, 1911, pp. 235–266, and Vol. 38, 1912, pp. 205–229.

P. Mougin: Les avalanches en Savoie, forming pp. 175–322 of Études glaciologiques, Vol. 4, Direct. Gén. des Eaux et Forêts, Minist. de l'Agric., Paris, 1923 (the bibliography gives 7 earlier works of the author, published or unpublished, and those of his collaborators of the Conservation des Eaux et Forêts de Chambéry, summarized in this very important work. See also the account in *Rev. de Géogr. Alpine*, Vol. 11, 1923, pp. 800–805). I have to thank the Inspector General of Forests, M. P. Mougin, for the right to reproduce the photographs of M. V. Hulin who made the collection for the French forestry administration. I am equally grateful to M. Hulin, chief of forestry of Grenoble, for the willingness with which he has placed at my disposition his knowledge, data, and photographs. With M. J. Brocherel, cited below, to whom I am equally indebted, he is a specialist in photographing avalanches. All his views are taken in Dauphiné; those of M. Brocherel come for the most part from the Italian Alps.

[5] Albert Heim: Handbuch der Gletscherkunde, Stuttgart, 1885.

Vincenz Pollack: Über die Lawinen Oesterreichs und der Schweiz und deren Verbauungen, *Zeitschr. Oest. Ingenieuz- und Architekten Vereins*, Vol. 43, 1891, pp. 18–39.

J. Brocherel: Le valanghe, *Emporium: Rivista Mensile Illustrata d'Arte, Letteratura, Scienze e Varietà*, Vol. 41, 1915, pp. 293–309.

E. Bénévent: La neige dans les Alpes Françaises, *Recueil des Trav. de l'Inst. de Géogr. Alpine*, Vol. 5, 1917, pp. 403–497.

F. Gex: Les avalanches du rebord subalpin de la Combe de Savoie, *La Géographie*, Vol. 39, 1923, pp. 36–52 and 165–179.

Idem: Les avalanches en Savoie durant l'hiver 1922–1923, *Rev. de Géogr. Alpine*, Vol. 11, 1923, pp. 487–511.

André Allix: Les avalanches de 1922–1923 en Dauphiné, *ibid.*, Vol. 11, 1923, pp. 513–527.

See also works cited later.

[6] J. G. Ebel: Anleitung, die Schweiz zu bereisen, 4 vols., Zürich, 1809.

Jules Michelet: La Montagne, 7th edit., Paris, 1868.

Charles Rabot: Pierres qui roulent, neiges qui tuent, *Lectures pour Tous: Rev. Universelle et Populaire Illustrée*, Vol. 6, 1904, pp. 505–513.

Mario Tedeschi: Le valanghe nell'Inverno, *La Sorgente*, Touring Club Italiano, Vol. 6, 1922, pp. 31–45 et al.

the work of Dr. Coaz. None can pass as definitive; the subject is too vast. The present work makes no attempt to be exhaustive. It simply aims to give an outline of the whole, especially intended for geogra-

FIG. 1—Glacier avalanche on the southern face of the Grandes Jorasses, French slope of Mont Blanc. (Photograph by J. Brocherel.)

phers. In the process some new observations will be presented, together with a plan for clarifying the vexed question of classification and a discussion of the only phase of the subject that has not received much attention—the prediction of avalanches.

Avalanches without Snow

A great variety of phenomena bear the name "avalanche" or an equivalent term,[7] *lavanches*, *laves*, *lavines*, *laui*, *lawinen*, *valanghe*, and yet fall outside the range of this study. They are accidents likely to occur at any season of the year and involving other material than snow. The fact that common speech has only a single word for these various occurrences is proof of their similarity at least as regards general appearance and human consequences; but physically and geographically they are entirely distinct phenomena. Earth slides are those which most nearly resemble snow slides. When a mass of earth begins to slide and still retains a certain cohesion it moves as a block or blocks without other apparent deformation than the change in level: this is the *foirage* (landslip) of the French authors and resembles the *planche* (board) of snow, the initial phase of the snowy avalanche. If the earth continues to slide a sufficient distance the mass breaks up, becomes pulverized, and then moves as a fluid substance; a phenomenon analogous to the course pursued by the ground avalanche. The terms "landslide" and "Bergstürz" are unfortunately common to the two cases.[8] Somewhat different but belonging to the same family is the rock flow, resembling in its movement, if abrupt a volcanic flow,[9] if slow a glacier. It has been well studied in America and Switzerland under the name of rock stream.[10] In both cases there is involved a mass of earth permeated with water and moving as a viscous fluid.

While lava flows, as their name indicates, belong to the same family, real avalanches of cinders or volcanic ash have also been studied, "dry avalanches," the characters of which are almost identical with those of snow avalanches.[11] Lastly all alpinists know that the cliffs of glaciers often give way in summer, producing "summer avalanches" or "glacier avalanches" (Figs. 1 and 2). Conditions of formation in this case are evidently entirely different from those of snow avalanches[12] and involve falls of ice rather than slides properly so termed. J. Brocherel has recently investigated an instance where a glacial slide has been provoked by the

[7] Abbé Gex has shown that the French and English term is a corruption of the old French term *lavanche*. This term, used in Savoy, Dauphiny, and Switzerland appears constantly in medieval chronicles latinized under the form *lavanchia*.

[8] I. C. Russell has studied accidents of the first class: Topographic Features Due to Landslides, *Popular Sci. Monthly*, Vol. 53, 1898, pp. 480–489; and Albert Heim accidents of the second: Über Bergstürze, *Neujahrsblatt der Züricher Natur. Gesell.*, 1882; Der Bergsturz von Elm, *Zeitschr. Deutsch. Geol. Gesell.*, Vol. 34, 1882, pp. 74–115. See also M. Neumayr: Ueber Bergstürze, *Zeitschr. Deutsch. und Oest. Alpenvereins*, Vol. 20, 1889, pp. 19–56; H. Ferrand: Histoire de la chute du Granier en 1248, *Ann. Club Alpin Français*, Vol. 9, 1882, pp. 580–602. Among the important accidents that of Flims is of the first class, those of Elm and Granier the second.

[9] P. Mougin: Les glissements de terrain, *Comptes rendus du Congrès de l'Alpinisme* (*Monaco, 1920*), 2 vols. in 1, Paris, 1921; reference in Vol. 1, pp. 423–433.

[10] André Chaix: Les coulées de blocs du Parc National Suisse d'Engadine (Note préliminaire), *Le Globe*, Vol. 62, 1923, Mémoires, pp. 1–35, Geneva, gives a bibliography completed by the account of A. Allix on that work, *Rev. de Géogr. Alpine*, Vol. 12, 1924, pp. 161–163.

[11] A. Lacroix: L'éruption du Vésuve en avril 1906, *Rev. Gén. des Sci.*, Vol. 17, 1906, pp. 881–899 and 923–936. It may be said that the term *coulée de lave* is, etymologically, a pleonasm.

[12] Such an avalanche takes place at the edge of "cliff glaciers" using this word in the restricted sense employed by W. H. Hobbs: Characteristics of Existing Glaciers, New York, 1911, p. 57. See also J. Brocherel: Éboulement et avalanches au Mont Blanc, *Augusta Praetoria*, Aoste, Italy, Vol. 2, 1920, 16 pp.

descent of a rock slide onto a glacier. This case, a true glacial flood, excepted, accidents of this kind in the Alps do not result in catastrophes analogous to those caused by snow because of the altitudes at which they take place.

Classifications of Snow Avalanches

Several classifications of snow avalanches have been proposed, a circumstance which in itself suggests that none has proved entirely satisfactory. One might almost say that every author has his own system, a new classification being *de rigueur* for each new work. As a matter of fact all the

Fig. 2—A small glacier avalanche on the summit of Ecrins (4103 m.), the upper part of the Glacier Blanc in Oisans. Note the man in the foreground. The camera was tilted at a large angle. (Photograph by A. Allix.)

classifications proposed bear more or less resemblance to one another, or rather are more or less easily recognized as pertaining to a single prototype—the classic division into *avalanches de poussière*, or *avalanches de surface*, and *avalanches de fond*. Hoek[13] gives the English rendering as "powdery avalanches" and "solid avalanches;" but, for the latter, "ground avalanche" would perhaps be more exact. This, the classification of Dr. Coaz and his followers, gives scientific form to a distinction long recognized by mountaineers. In the sixteenth century Josias Simler and, in the eighteenth century, Scheuchzer had already given expression to such an idea.[14]

[13] *Op. cit.*

[14] Josias Simler: Vallesiae et Alpium descriptio (1st edit., 1574), edited and translated by W. A. B. Coolidge in Josias Simler et les origines de l'alpinisme jusqu'en 1600, Grenoble, 1904.

J. J. Scheuchzer: Itinera per Helvetiae alpinas regiones facta annis 1702–10, 4 vols., Leiden, 1723. Cf. Hess, *op. cit.*, p. 305.

FIG. 3

FIG. 4

FIG. 3—"Snowslip" avalanche in the high mountain. Note the formation of *grelots*. (Photograph by courtesy of J. Gaberell, Thalwil, Switzerland.)
FIG. 4—"Fountain" avalanche below the Meije (3987 m., summit on the extreme right), Oisans. (Photograph by Nouvion.)

TABLE I—CLASSIFICATION OF AVALANCHE TYPES

STATE OF SNOW BEFORE DEPARTURE		DEPARTURE: Flowing	DEPARTURE: Rolling	DEPARTURE: Sliding			COURSE	ARRIVAL: In single flow (*en un temps*): On slope	ARRIVAL: In single flow (*en un temps*): In ravine	ARRIVAL: In compound flow (*en plusieurs temps*): On slope	ARRIVAL: In compound flow (*en plusieurs temps*): In ravine	STATE OF THE SNOW ON ARRIVAL	
Dry (cold avalanches)		Floury	Snowball (*boule*)	Snowboard (*planche*)	Short	Cascade	"Spout" (*en trombe*)*; "Fountain" (*en fontaine*); Superficial or lightning-flow (*coulée-éclair*)*; Deep (rapid flow)†	Simple cone or fan	Simple tongue (cf. glacial tongue)	Grooved cone	Grooved tongue	Homogeneous	
					Long	Flow (*coulée*)						In lumps	Clean; Earthy
Wet (warm avalanches)	Light (fresh snow)		Snowball (*boule*)	Tile (*tuile*)	Long		"Fountain" cascade			Palmate cone		In lumps	Clean; Earthy; Woody; Earthy and Woody; Streaky
	Heavy (old snow)			Snowslip (*foirage*)	Short; Snow shield (*bouclier*)		Flood (*coulée*): Rapid†; Slow§						

* Powdery avalanche of usual classification. † Type of powdery-ground avalanche of usual classification. § Ground avalanche of usual classification.

Zdarsky has shown that the ground avalanche, in the ordinary sense, does not necessarily remove all the snow layer and, inversely, that the powdery avalanche may sometimes lay bare the surface. Hoek, again, has given more precise meaning to these two terms. He understands by powdery avalanche "that which is formed of fresh snow, light and fine; and by ground avalanche that which is formed of wet, compact, agglutinated snow." Dr. Paulcke, who in his manual of skiing distinguishes powdery avalanches, ground avalanches, and powdery-ground avalanches (*avalanches de fond poudreuses*), has given in the fourth edition of the celebrated work of Zsigmondy a classification of avalanches based on the condition of the snow: fresh (*Neuschneelawinen*) or old (*Altschneelawinen*). Avalanches of fresh snow fall into two categories according to whether the snow is dry or wet. Meyer von Knonau distinguishes four categories: powdery (*Staublawinen*), ground (*Grundlawinen*), sliding (*Schleichlawinen*), and "tile" (*Schlaglawinen*).[15] V. Hulin recognizes six: (1) *volante*, corresponding to the *Staublawine;* (2) *terrière*, corresponding to *Grundlawine;* (3) *mixte*, a combination of the two previous forms, corresponding to Paulcke's *avalanche de fond poudreuse;* (4) *rampante*, corresponding to the *Schleichlawine;* (5) *en tuile*, corresponding to the *Schlaglawine;* (6) *de surface*, corresponding to *Oberlawine* but including in Hulin's classification the case of the "balling" avalanche. Finally, the last classification, proposed by Max Oechslin, is simply a return to the first—surface avalanches (*Oberlawinen*) and ground avalanches (*Grundlawinen*).

Obviously all these classifications, which reflect more or less common observation and make use of popular expressions, are of an empirical character. Many authors, in particular P. Mougin, insist on the number of complex types which cannot be placed in set categories. As a matter of fact none of the above classifications is satisfactory because each has considered the question from one viewpoint only. The majority adopt as a basis the method of fall and neglect the condition of the snow; that of Paulcke-Zsigmondy takes the reverse stand.

Attempt at a Rational Classification

Now there is only one means of uniting the two principles of classification; that is to draw up a double-entry table, making a place for all possible combinations. It will be recalled that it was by this method that Rinne introduced clarity into the classification of eruptive rocks.[16] In the accompanying table I have attempted to place thus all forms of avalanches known to me either from personal experience or in scientific literature. The value of such a table depends in considerable measure on the choice of rubrics. As regards the state of the snow I have discarded Paulcke-Zsigmondy's subdivision though it is the only one along these lines proposed up to now.

[15] Gerold Meyer von Knonau: Erdkunde der schweizerischen Eidgenossenschaft, 2 vols., Zürich, 1838–39.

[16] Friedrich Rinne: Praktische Gesteinskunde, 2nd edit., Hanover, 1905. French adaptation by L. Pervinquière: Étude pratique des roches, 2nd edit., Paris, 1912.

For age of the snow gives no indication of its condition, beyond a surmise as to its density. Fresh snow will give rise to very different types of avalanches according as to whether it is cold or warm, that is to say dry or wet. It is, I believe, this last distinction upon which the nature of an avalanche primarily depends. In making the distinction between dry and wet snow fundamental I am only conforming to an empirical classification which is well known to the mountaineer and which I am surprised not to have seen

FIG. 5

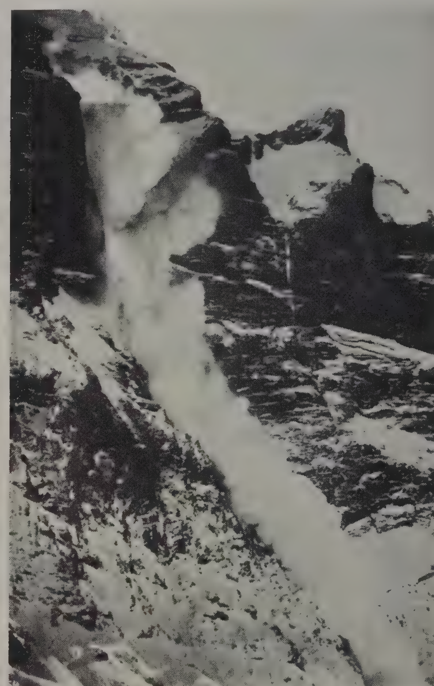

FIG. 6

FIGS. 5 and 6—Two unique photographs of powdery avalanches in descent. (Fig. 5 by C. Grauwiller, Grindelwald; Fig. 6 by W. Nehrkorn, reproduced by permission of R. Schudel, Grindelwald.)

discussed by any of the numerous theorists of the subject; only Charles Rabot mentions it incidentally—the division into cold avalanches (*avalanches froides*) and warm avalanches (*avalanches de chaleur*, which for correspondence of term I will call *avalanches chaudes*), it being understood that the term "warm" is purely relative. This mountaineer's classification is the only one in which the terms are mutually exclusive; that is to say in which combinations are impossible.

The cold avalanche comprises almost all occurrences classified by Coaz as powdery avalanches; it is more comprehensive than that of the simple superficial avalanche. The cold avalanche involves the movement of dry snow; it takes place in winter, most often during the time of greatest cold, and almost always coincides with a drop in temperature.

The warm avalanche is produced only when there is a thaw; it involves the movement of wet snow. Contrary to a widely held opinion, it can take place in winter as well as spring; it is incorrect to designate it "spring avalanche" as opposed to "winter avalanche." The warm avalanche includes the greater part of the avalanches classified by Coaz as ground avalanches.

In classifying according to conditions of fall the difficulty is to find place for the aborted avalanche, that is to say such as is arrested in the stage of departure. All alpinists know this as a very common case of which the type form is the *planche* of snow, the "snow board." It occurred to me that the point of view to adopt was that of the several stages of development. Heim had already distinguished the zones of departure, course, and arrival (*Abrissgebiet*, *Lawinenzug*, *Lawinenkegel*) but he had not utilized the distinction as a basis of classification. Used thus it permits us to distinguish, as no classification has done heretofore, the very varied forms presented by avalanches both in the course of their fall and after their arrest. The cone of the avalanche in particular assumes a great number of different forms, dependent on the mode of fall, surface topography, and nature of the snow.

The Starting Point, or Zone of Departure

Ski runners are well aware of the capricious variations of the snow surface. It needs but little experience to become acquainted with the rapidity with which it can change in consistency, density, cohesion, according to meteorological conditions and the time of day. It has been well said that on this subject even the most skillful ski runner has something to learn. These diverse aspects of the snow must be taken into account in classifying avalanches according to the zone of departure.

COLD AVALANCHES

Cold snow may be either fresh and light or old and compressed. In the latter case it is almost always congealed, more or less transformed into a bubbly kind of ice. It is exceptional that such snow slides. Cold avalanches are composed only of light snow that lacks cohesion. The snow may lie directly on the ground—a circumstance unfavorable to the formation of an avalanche but not necessarily prohibitive. It may rest upon a layer of older and harder snow, which affords an excellent sliding plane. Here arises the customary confusion between cold avalanches and superficial avalanches.

This snow, as we have said, is characterized by feeble cohesion. It may be floury in its entire thickness; it may be floury under a thin crust of harder snow or ice. When more compressed it will grind, hardening under the pressure of the skis; in this case it may again be homogeneous or crusted. According to Max Oechslin, who has made a critical study of the matter, fresh snow has a density of 0.07; and compressed snow, two days after

falling, a density of 0.20. Avalanches of floury snow are rare, because snow changes consistency a few hours after falling, becoming more coherent.

Schlagintweit (cited by Heim) established the category of "balling avalanche" (*avalanche en boule; Rolllawine*). V. Hulin took it to be a particular case of superficial avalanche. In reality its occurrence is rare, especially in cold snow, and it never attains significant dimensions. A foreign body falling on the surface of snow may determine the formation of a ball, which when once started rolling will continue to grow by the accumulation of more snow. But if the snow is coherent the ball will *always* be arrested before it has gone far, friction and adhesion exceeding the motive force. On the other hand if the snow is but slightly coherent and needs only to be put in motion, the disturbance caused by the rolling of the ball will soon enough determine the starting point of a normal avalanche (compare footnote 19). The motion of the normal avalanche itself almost always causes the formation of globular lumps of snow, *grelots*, of which more anon.

Cold compacted snow gives rise to the commonest initial form of cold avalanche, the *planche* of snow, "snow board," the *Schneebrett* of the German writers.[17] The layer of snow has the appearance of being cut up into a number of plate-like sections, the dimensions of which are on the order of 100 meters by 100 meters. This marquetry may result from alternations of temperature, with corresponding movements of expansion and contraction. It is most often produced in crusted snow, though this condition is not indispensable. The least disturbance, the simple cutting of a deep track by alpinists in single file may lead to the slipping of one of the sections of the marquetry. It will break away with a loud report like a rifle shot. The slipping of the snow in relatively coherent plates has naturally the effect of exercising vigorous compression in the lower part. This may be so violent as to give rise to a creaking noise—the snow "cries." The lower part of the snow board plowing forward raises a series of eddy-like waves. The alpinist taken by surprise loses his equilibrium at the arrival of the first of these eddies; he is swept off his feet and plunged head downwards into the mass of moving snow in which he may be buried by successive waves unless he keep on the surface by a swimming motion.

In the lower parts of the avalanche the snow is powerfully compressed. As Tyndall's classic experiments demonstrated, compression causes congealing. However light it was at the point of departure the snow then always becomes hard as ice. M. Pierre Lory told me his experience on Belledonne where he was surprised by a diminutive avalanche. The movement of the hard snow wrenched the ice axe from his hand with an irresistible force.[18] It is this hardening of the snow that renders death almost inevitable if rescue is not at hand, for the alpinist thus caught who is not able to regain the surface finds himself paralyzed in a sheath of ice. Victims who sink in deeply can only be reached by rare good fortune.

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[17] Excellent photograph in the work of Hoek and Richardson. Dr. Hoek has given the best descriptions of the phenomenon and has proposed the English equivalent snow board (*op. cit.*).

[18] See also the account by Mrs. Clark, cited below, footnote 44.

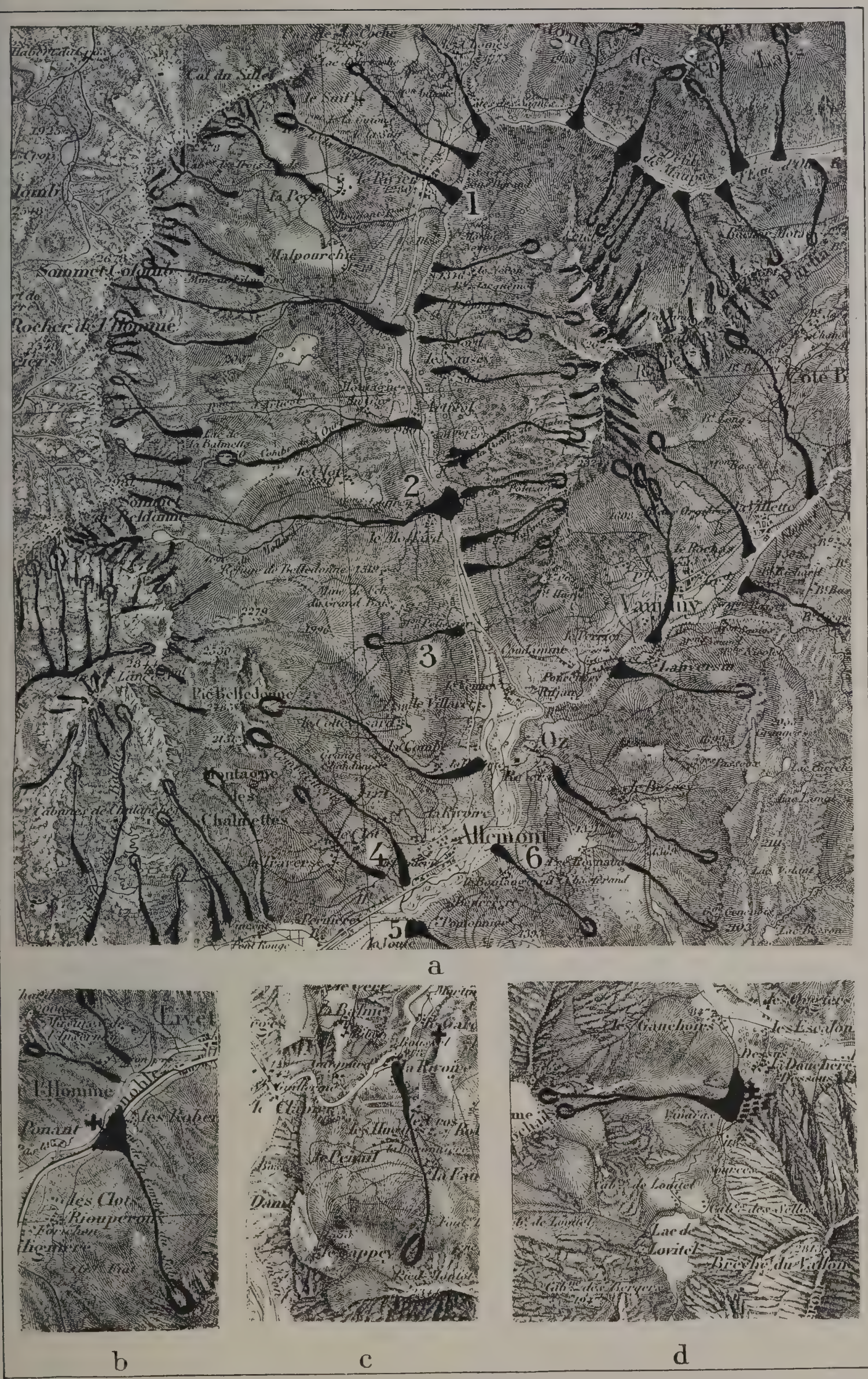

FIG. 7—Avalanches in the Oisans region, east of Grenoble, shown on the French General Staff map 1 : 80,000 (slightly reduced). *a*—Avalanches of 1923 in the valley of Eau d'Olle. Numbers have reference to photographs: 2 is shown in Figure 26, 3 in Figure 21, 4 in Figures 29 and 30, 5 in Figure 12, 6 in Figure 22. *b*—Avalanche of Roberts, Livet, March 3, 1923. The cross indicates the point whence the photograph Figure 25 was taken. See also Figure 27. *c*—Avalanche of La Rivoire, Mont-de-Lans, March 3, 1923. The cross indicates the point whence the photograph Figure 13 was taken. See also Figures 19, 20, 32, and 33. *d*—Avalanche of La Dauchère, Venosc, February, 1904 (after data by Pierre Lory). The dashes indicate the course taken by the "wind of the avalanche," the cross the point whence the photographs Figures 10 and 11 were taken.

FIG. 8—Avalanches on the Col Ornon, Taillefer massif (Dauphiné), May 3, 1923, two months after their descent. (Photograph by V. Hulin.)

When thus compressed, crushed, and overturned the snow plates break up, assuming the form of more or less rounded lumps usually the size of a man's head or even larger (Fig. 3). These *grelots*, as V. Hulin has termed them, are characteristic of the snow of avalanches. It is exceptional that the snow slides in a homogeneous mass without the formation of *grelots:* this happens practically only in the case of floury snow.

WARM AVALANCHES

Warm snow is always damp. Consequently it is more cohesive than cold snow. It is also heavier. Max Oechslin gives 0.45 as the density of fresh

FIG. 9—An avalanche at Petites Sables (Oisans), December 31, 1922. No damage has been done to the wood through which it has passed.

wet snow, and 0.70 to 0.85 for old wet snow compacted by pressure. This snow may be more or less water-soaked, more or less granular, more or less "sticky" to the skis; it may be either crusted or uncrusted. It slips in masses, larger and slower in movement than the cold snow. Warm snow never has a floury appearance. When rolling balls are formed in this kind of snow they have exactly the same character as those formed in cold snow and the comments made above in regard to them are applicable here.[19]

A type of avalanche peculiar to warm snow is the *tuile* or tile. Wet snow *always* slides on the slopes that it covers, though this movement may

[19] "I cannot sufficiently emphasise the fact that a 'balling' avalanche never occurs—no such thing as a house-high giant's football." (Hoek, *op. cit.*, p. 382, note.)

be very slow. P. Mougin and Max Oechslin have both made investigations thereon.[20] The phenomenon may be observed in winter on any house roof—on any snow-covered slopes, in fact, provided the inclination is sufficient. On the edge of the roof the layer of snow slips down and overhangs for a time until the force of cohesion is overcome, when it breaks, precipitating a "tile" of snow on the ground or the heads of unwary passers-by. This little accident is common enough in the alpine regions and is the reason why the roof slopes are generally broken up by horizontal laths or bordered by little parapets.

On a continuous slope the rupture of the layer of wet snow is followed by a rapid sliding which accelerates to a velocity limited by friction and the varying inertia of moving snow. This is a phenomenon quite comparable to that of the snow board, although it is slower, and it always leaves the ground exposed (Fig. 3).[21] It is similar enough to a landslide, and I suggest expressing it by the same term *foirage*, rendered in English by "snowslip."

As in the case of earthy material the *foirage* may be shortly arrested and compacted in place (Fig. 3). Such a condition may be termed *bouclier*, "snow shield" (*Schneeschild*). It appears to me best to limit the term thus rather than apply it as Hoek and other German writers have done to the cold snow board. If the snowslip continues its course, it develops snow waves and breaks up with the formation of *grelots* as in the snow board.

Before turning to the second stage we must state the degree of slope which permits the formation of rapid slides. Hoek defines as dangerous a slope of 23°; Rütgers places it between 22° and 25°. Max Oechslin has observed the departure of an avalanche on bare frozen ground on a slope of about 16°. It would appear, however, that such a case is exceptional and that the normal value of the critical angle is the average given by Hoek.

Zone of Course

The snow board or the snowslip, as we have seen, can be arrested in the departure stage when we have what I propose to call "short" slips. If the snow continues its progress we have "long" slips, which are transformed into flows. Rarely does the flood of snow spread over a broad slope (Fig. 3). Most often it sooner or later molds itself into a ravine; this is the *couloir* or chimney of the avalanche. Hobbs uses the term *couloir* to express this idea in English; it would appear to me preferable to use the term "gully" for the former word and "funnel," suggested by Hoek, for the latter.

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[20] This sliding has never been clearly observed for absolutely dry snow. It is probable that it takes place, but the lack of cohesion renders impossible the phenomenon of the *tuile*, it being replaced by the cascade of powdery snow.

[21] Max Oechslin has an interesting photograph of a slide of this nature on its way, leaving bare the ground behind it.

COLD AVALANCHES

It often happens that the gully of the avalanche is interrupted by an abrupt break in slope. In such case the snow is precipitated forward as a "waterfall" of snow coming to rest with the noise of a thunderclap. With very floury snow the cascade may appear as suddenly as a dust whirl. The crystals of snow are so light and loose that they whirl in the air like dust. Photographs of such cases are very rare (Figs. 5 and 6).

When the snow is a little more compacted and when it is composed of lumps the cascade is slower and more continuous. From afar it may closely resemble a waterfall in appearance though the wind raises only a little white dust about it. This I propose to term "fountain" (Fig. 4). The "fountain" may run for several hours, even days, with occasional interruptions; it produces a rumbling noise, dull and intermittent.

When the slope is regular there is only a flow. The snow may be powdery or in lumps; if the former it will be accompanied by a great flurry of snow dust. Sometimes the speed acquired is sufficient to raise the entire mass of snow in the air. This is the avalanche of snow dust proper (Fig. 6). It is most likely to happen where powdery snow slides over a surface of old snow and thus attains great speed. I have given this form the term "superficial flow" (*coulée superficielle*) or lightning flow (*coulée-éclair*). The speed attained may be 300 to 400 kilometers an hour.

When dry snow slides over the ground leaving it bare the movement is slower, though still comparatively rapid, and gives rise to less flying dust. It corresponds to the powdery-ground avalanches produced in cold snow. I call it "deep flow" (*coulée profonde*) or "rapid flow" (*coulée rapide*). Its velocity ranges from 100 to 200 kilometers an hour.

WARM AVALANCHES

It sometimes happens that lumps are not formed in light snow. This is when the snow is very wet and flows as a semi-liquid, like a sherbet, having a homogeneous consistency (Figs. 9, 23, 24). But in the vast majority of cases, and invariably when the snow is dense, lumps are formed. The warm avalanche may descend as a cascade when the relief is suitable, but the fall in such case is slow and continuous—a fountain. I have described elsewhere one that flowed for more than three weeks before being replaced by a waterfall.[22] In Figure 8, a view taken in spring, are cascades of water along the gullies where earlier flowed the snow fountains.

Light wet snow gives rise to rapid flows that attain speeds of 100 to 200 kilometers an hour. Examples are known where such snow slides over an underlying layer of old snow; snow dust is then produced. This category includes all powdery-ground avalanches formed in warm snow.

Heavy wet snow always flows more slowly. The "slow flow" (*coulée lente*) of the table has a mean velocity of 20 to 50 kilometers an hour.

[22] Allix, Les avalanches de 1922–1923 en Dauphiné, *Rev. de Géogr. Alpine*, Vol. 11, 1923, p. 520, Fig. 10.

FIG. 10—Complex avalanche that fell at La Dauchère, Venosc, Oisans, February, 1904. Note on the left the wall of snow, six meters high, piled up by successive flows of the first avalanche (heavy wet snow). Four days later a powdery avalanche cut a deep striated furrow across the earlier cone. Compare Figure 11. (Photograph by Pierre Lory.)

FIG. 11—Effect of the "wind of the avalanche" that accompanied the second avalanche at La Dauchère (Fig. 10). See Figure 7*d*. (Photograph by Pierre Lory.)

Speed is retarded not only by its weight and its adhesion to the ground but by the foreign bodies it plucks up and carries along—earth, rocks, trees. J. Brocherel asserts that an avalanche of this sort, heavily laden, may flow with the slow majesty of a lava stream; though I myself have never observed such slowness of motion. Avalanches of wet heavy snow form the classic category of ground avalanches.

Both slow and rapid avalanches may slide with a single motion. This I have termed the "single flow." Most often descent is accomplished by several consecutive flows. Strangled at the opening of a ravine too narrow to accommodate its bulk the snow divides into masses which, being thrown about, knocked together, and hurled against the sides of the ravine, behave in an astonishing way and later on take most surprising forms. Abbé Gex has given a lively description of this smashing up of the avalanche by itself.[23] This I have termed the "compound flow." The successive flows are differently charged with foreign matters, some perhaps being constituted of pure snow; hence here is a distinct banding in the zone of arrival, where the course of the avalanche is finally arrested.

Zone of Arrival

In the zone of arrival warm and cold avalanches give rise to the same forms. Differences in form depend on the mode of fall and on the relief of the ground whereon the avalanche falls.

Falling at the foot of a slope the avalanche will produce a cone, or fan, of snow. If arrested in the ravine the form resembles the tongue of a glacier. The single flow gives a simple cone (Fig. 8, to left; Fig. 9) or a simple tongue. The compound flow results in a grooved appearance; this may be termed the "grooved cone" and "grooved tongue." The grooved cone is much the more common (Fig. 12), but the grooved tongue is also frequently seen (Fig. 20). The photograph, Figure 10, presents a magnificent example of a grooved cone whose genesis is exceptionally interesting.[24] This phenomenon took place at La Dauchère (commune of Venosc en Oisans) in the Lauritel valley, in February, 1904. A first avalanche of heavy wet snow (ground avalanche) produced a great grooved cone. Four days later, following a considerable drop in the temperature and a fall of snow, a cold avalanche (powdery avalanche) occurred on the same spot and traced an enormous groove on the earlier cone, thus constituting what is in fact a double-grooved cone.

Sometimes the occurrence of powdery and ground avalanches is practically simultaneous. It may happen that the fall of a cold avalanche from a great height starts the descent of an avalanche of heavy wet snow in lower and warmer regions. Rarely, however, can the two phenomena be distinguished in such case, for the former is generally of smaller volume and

[23] F. Gex: Les avalanches en Savoie durant l'hiver 1922–1923, *Rev. de Géogr. Alpine*, Vol. 11, 1923, pp. 487–511.

[24] For this unpublished photograph and accompanying data I am indebted to P. Lory; see footnote 36.

is absorbed by the latter. More commonly one sees an avalanche of wet light snow at a high elevation start in train lower down an avalanche of heavy wet snow. The coincidence of powdery and ground avalanches is generally to be interpreted this way. G. Brocherel has a beautiful photograph taken at Courmayeur in which are seen side by side gullies occupied respectively by a powdery avalanche and a ground avalanche leading to a single-grooved cone.

FIG. 12

FIG. 13

FIG. 12—Avalanche at La Voute d'Oz, Oisans, on March 3, 1923. The scar marking the point of departure has been lightly reinforced. See Figure 7*a*, No. 5. (Photograph by V. Hulin.)

FIG. 13—Avalanche at La Rivoire, Mont-de-Laus, Oisans, on March 3, 1923. The scar marking the point of departure has been lightly reinforced. The cross in the foreground marks the site of a house overwhelmed and destroyed (Figs. 32, 33). See also Figure 7*c*. (Photograph by V. Hulin.)

When the snow is not very abundant, or when the successive flows travel with very different speeds, some go farther than others and are apt to follow divergent tracks. This is less easy to observe in winter when the ground is covered with a mantle of snow, but it is apparent enough in the spring when the superficial snows have melted and only the accumulated masses of the avalanches survive. It gives rise to a special type of cone rarely mentioned in spite of the frequency of its occurrence; I propose to term it "palmate cone." Figures 17 and 18 show two views of a true palmate cone; Figure 16 has side by side with a true palmate cone a false form produced by the confluence of two avalanches, one of which has partially ridden over the other.

The uninformed observer might imagine that the cone of the avalanche is of much greater dimensions than the little scar in the form of an inverted

tear left high up on the mountain slope by the snow as it departs (Figs. 12, 13). Hence the belief in the existence of tributary avalanches which swell the main flow. In reality it is only an optical illusion due to perspective, and the error may be corrected by examining the map (Fig. 7). The case of a tributary avalanche is rare; two are figured on the map, Figure 7*a*, one to the south of Belledonne—which, however, is hypothetical, for this valley is inaccessible in the season of avalanches—and the other above Vaujany.

Tongues and cones present very different forms and attain very different distances in successive years. The avalanche shown in Figure 12 most often forms a tongue in its ravine; in 1906, however, the flow, while much thinner than in 1923, traveled farther. Figures 17 and 18 show the same palmate cone in 1923 and 1904 respectively; sometimes it appears as a tongue, sometimes as a cone. When a flow is launched with particularly high speed, instead of stopping at the foot of the slope it may be carried a distance up the opposite side. About 1860 the avalanche of Roberts in Oisans (Fig. 7*b*) crossed the bed of the Romanche and carried great tree trunks to a height of more than fifty meters up the opposite bank.

In the zone of arrival the snow may be homogeneous, but most often it has the customary form of globular lumps. Heim, who has remarked their abundance (*ein ungeheurer Zahl von Schneeballen*), shows that they may affect the most varied forms: balls, discs, ellipsoids, cylinders, etc. But when alternate thawing and freezing has been in progress for some days (and this has generally been the case when the cone is studied) the form of the lumps tends to be regularized (Fig. 14). Exceptionally they attain great size, dimensions on the order of a cubic meter (Fig. 15). These are produced, I believe, in the last stages of the fall of a light, very wet snow compacted suddenly towards the end of the descent.

Simple cones may be composed of pure snow or of snow charged with various materials collected in the descent. Grooved and complex cones often present a streaky appearance, each flow having reacted in its own particular manner to the surface over which it progressed (Fig. 24). Generally the latest flows are those bearing most earth, but there are exceptions. On the right hand side of Figure 8 is seen a small earthy cone; Figure 21 shows an avalanche charged with wood; Figure 28 an earthy and woody avalanche.

The cone of the avalanche takes long to melt; sometimes a residuum remains from year to year. P. Mougin has noted an avalanche that fell in 1860 in Upper Tarentaise and served as a bridge across the Isère for seventeen months. Nothing is more dangerous, as Abbé Gex has pointed out, than the exploration of one of these cones. When the avalanche falls the lumps are often massed together in unstable equilibrium, the hollows being concealed. Again the melting snow is usually sapped from below with the formation of snow grottoes, and the rash tourist proceeding onto the surface falls through. When melted the cone of the avalanche leaves behind a more or less extensive débris of earth and wood, the "crasse" (Gex).

FIG. 14

FIG. 15

FIG. 14—The interior structure of a ground avalanche: *grelots*, lumps, of snow rounded and united by several days of alternate thawing and freezing. (Photograph by J. Brocherel.)

FIG. 15—Large balls of snow remaining in a half-melted avalanche at Villard d'Entraigner (Dauphiné), 1911. For size note the man in the middle of the scene. (Photograph by V. Hulin.)

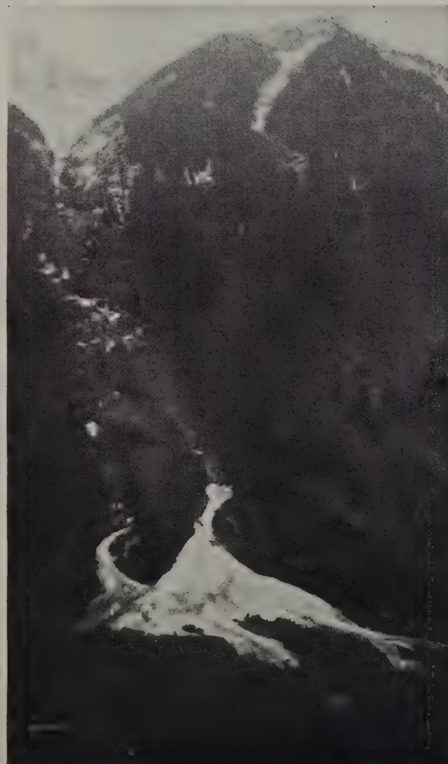

FIG. 16

FIG. 17

FIG. 18

FIGS. 16, 17, and 18—Palmate cones of avalanches in the Romanche Valley, Oisans. Figure 16 shows the avalanche of Treuil in April 1923, six weeks after its descent, and Figure 17 similarly the avalanche of Vaudaine. (Both photographs by V. Hulin.) Figure 18 shows the avalanche of Vaudaine in 1904. (Photograph by Pierre Lory.)

Frequency of the Various Types

It is difficult to give even an approximate idea of the relative frequency of the several types of avalanches. Coaz and Mougin have both attempted an estimate, from which it appears that ground avalanches are much the most numerous. In Savoy during the period 1900–1901 to 1913–1914, out of an annual average of 586.4 avalanches Mougin classed 421.3 as ground avalanches, 31.5 as powdery, 131.8 as superficial, and 1.8 as glacial. That is ground avalanches constituted nearly 72 per cent. It will of course need several years' observation before percentages can be given according to the author's classification. The predominance of avalanches of heavy wet snow may be explained by the fact that they are often provoked by the occurrence of other types.

Effects of Avalanches: Are They Beneficial?

All told, the avalanche is a subordinate type of phenomenon, and interest in it must be considered purely theoretical unless it has a powerful reaction on the conditions of life in the mountains. One may first ask if it has any favorable effects in this regard. An old theory has led many authors to answer this question in the affirmative. Tschudi, cited by A. de Quervain, states specifically that "the devastation wrought is insignificant compared with the benefits bestowed." Abbé Gex, an observer of the first rank, recently revived this theory, though he does not appear to have been aware of Tschudi's text nor the criticisms of Coaz and de Quervain.[25] He does not go as far as Tschudi (and more recently V. Hulin) to say that the chief rôle of the avalanche lies in the favoring of vegetation by premature removal from the mountains of their encumbering mantle of snow;[26] but in his opinion the residual earth and wood left by the avalanches afford compensation in fertilization of the soil and provision of fuel. He also specially mentions the function of the masses of snow as valuable reservoirs of water capable of regulating, if not of increasing, the discharge of springs and streams. He even designates these masses of old snow as "infant glaciers," a pretty expression but one likely to convey a false idea. Comparison to a miniature glacier may be useful to describe the appearance of the avalanche tongue in a ravine,[27] but it only holds good from the descriptive point of view. On scientific grounds, whether glaciological or hydrological, it is adventitious; structure, motion, effects are in no wise similar.

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[25] F. Gex: Rôle et utilité des lavanches, conclusion (pp. 169–178) of the article "Les avalanches du rebord subalpin de la Combe de Savoie," *La Géographie*, Vol. 39, 1923, pp. 36–52 and 165–179. See also *idem:* Les avalanches en Savoie durant l'hiver 1922–1923, *Rev. de Géogr. Alpine*, Vol. 11, 1923, pp. 487–511.

[26] According to Coaz the proportion of snow carried off by avalanches is at the maximum a quarter of the total snow surface. A. de Quervain (*Sport*, 1922) reduces the figure to one-tenth. It appears to the writer that this should be still further diminished.

[27] Cf. Allix, Les avalanches de 1922–1923 en Dauphiné, *Rev. de Géogr. Alpine*, 1923, p. 520 and Pl. iv, Fig. 11. See also Figure 13 of this article which represents the same tongue from another viewpoint.

Hydrologic and Climatic Rôle

It is, however, incontestable that avalanches in which the snow is congealed conserve a certain quantity of water where they fall. If such snow had remained in a thin layer on the slopes it would have melted with the first warm days of spring; accumulated in thick packets and well sheltered at the bottom of a ravine it may take all summer to melt, and a residuum may indeed last the year round. As a practical matter an attempt has been made to estimate the quantity of water thus put in reserve. The reforestation service with Grenoble foresters under the direction of V. Hulin has undertaken studies of this nature by setting up bench marks. In the ravine of Vaudaine (Oisans) systematic observations have been undertaken, following the method employed for estimating the frontal variations of glaciers. It is still too early, however, to draw conclusions therefrom.

But the beneficent hydrological rôle does not appear to be very considerable at first glance. Really to evaluate it, it would be necessary to compare the discharge of streams from a given basin in years when there were many avalanches with the discharge in years when avalanches were few, and this has not yet been done. Offhand it would seem that the snows of avalanches would swell the streams only in the summer season when they are already well fed by glacial melting and that the avalanche's rôle of regularization is thus very limited: it is in winter that the alpine streams lack water. Only a small part of the melted water of spring could be kept till summer, and that is not very certain. It has been shown that a great part of the summer flood even in the high mountain comes less from the melting of glaciers or masses of snow than by restitution of the spring waters absorbed by the soil.[28] Now these spring waters are almost entirely derived from the melting of the snow cover. Preserved in the soil or in avalanche cones, I believe that the water coming from the snow arrives at practically the same moment in the streams and thus that the regulating rôle of the avalanche is reduced to insignificance.

Great avalanches have another hydrological effect, considerably less important in its consequences because of its brevity but very striking at the time of occurrence: this is the temporary damming up of stream beds (Fig. 22). In March, 1923, the Vénéon in Oisans abruptly ceased to flow for more than an hour, and this was the only indication one had downstream of the occurrence of a great avalanche in the upper valley. It is rare, however, that a stream is interrupted for long in this way.

Important climatic effects have also been attributed to avalanches, notably a lowering of temperature in years when avalanches are numerous. A. de Quervain, a master of the subject, has done justice to this hypothesis. A winter of heavy snows may have an influence on the temperature of the following summer, as on the alimentation of glaciers; but the effect of ava-

[28] André Allix: La crise de la houille blanche dans les Alpes françaises, *La Géographie*, Vol. 39, 1923, pp. 307–320.

lanches in this respect amounts to nothing. The lowering of temperature is strictly local: it is only over a radius of some dozens of meters[29] that a sensible retardation in the development of vegetation can be recognized.

FIG. 19

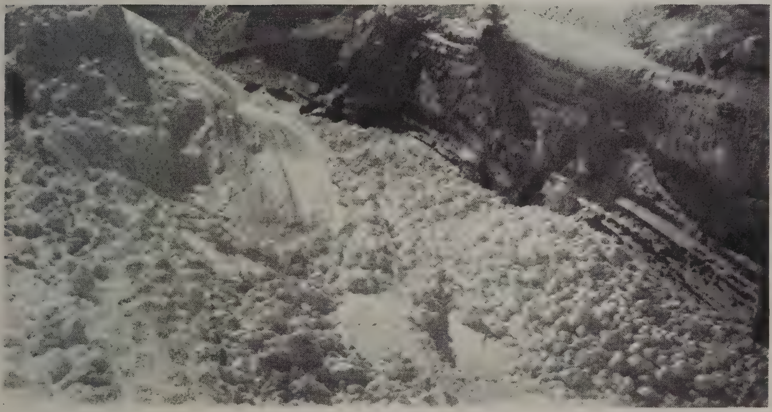

FIG. 20

FIGS. 19 and 20—Gouging action of a ground avalanche in earth and snow respectively. Avalanche of La Rivoire, March 3, 1923. (Photographs by A. Allix.)

Morphological Effects: Erosion by Avalanches

On the contrary, direct observation shows that avalanches are capable of exerting a powerful morphological action. Up to now this action has invariably been underestimated. In an article otherwise fundamental M. de Martonne makes only brief allusion thereto.[30] Abbé Gex places the morphological action of avalanches at much less than that of running water in the same channels. This opinion I do not share.

[29] Gex, Les avalanches du rebord subalpin de la Combe de Savoie, *La Géographie*, 1923, p. 176.

[30] Emmanuel de Martonne: Le rôle morphologique de la neige en montagne, *Comptes rendus du Congrès de l'Alpinisme* (*Monaco, 1920*), 2 vols. in 1, Paris, 1921; reference in Vol. 1, pp. 335–344; and *La Géographie*, Vol. 34, 1920, pp. 255–267. It may be remarked, however, that this work, which deals with entirely original matters, expressly omits avalanches as a subject already well studied.

The sides of the high mountains are generally ravined by gullies known to alpinists, by whom they are carefully avoided, as avalanche gullies (*couloirs d'avalanches*). Possibly subaerial action, especially alternate freezing and thawing, accomplishes more work here than the occasional friction of falling masses of snow: usually gullies particularly dangerous because of avalanches are likewise dangerous because of falling stones. Again, below a certain altitude the action of meteoric water is clearly recognized in the ravines. Yet there appear to be cases where sliding of the snow acts alone as an erosive force, or at least has the preponderant

FIG. 21—An avalanche loaded with trees after traversing a forest. Combe-Longe, Allemont, Oisans, March 3, 1923. See Figure 7*a*, No. 3. (Photograph by V. Hulin.)

rôle. Reference may be made to a number of classic illustrations, views taken near the crests of high snowy mountains; the Canadian Rockies, the Himalaya,[31] and the New Zealand Alps.

If a rock can be found that is practically unaffected by the work of running water in a position where avalanches are a characteristic phenomenon, one has a test case of their erosive power. Now such a rock does exist. Long ago I called attention to a wall of fissured limestone, in Vercors (French Prealps) between the Col de l'Arc and the Col Vert, which is furrowed each spring by multiple avalanches. It exhibits a relief etched in parallel channels similar to the classic form that Sven Hedin has described in the countries of eolian erosion under the name *yardangs*. I do not believe that it is possible to interpret these forms other than as the work of avalanches.[32]

Furthermore, the powerful erosive action of a snow flow is manifested by its gouging action on the walls of the gully in which it flows (Fig. 19).

[31] See in particular several photographs of the British Expedition to Mt. Everest; notably that of Makalu facing p. 226 of "Mount Everest: The Reconnaissance, 1921," London, 1922. See also André Allix: Les enseignements du Mont Everest, *Rev. de Géogr. Alpine*, Vol. 12, 1924, pp. 99–128.

[32] André Allix: La morphologie glaciaire en Vercors, *Recueil des Trav. de l'Inst. de Géogr. Alpine*, Vol. 2, 1914, pp. 1–185. These forms are much too extensive to be mistaken for enlarged lapiés.

P. Mougin has already demonstrated this clearly.[33] This action, however, is not to be confused with the grooves cut across the cone by a compound flow; Figure 20 shows the two phenomena side by side.

F. Gex has made the just observation that the avalanches of a ravine contribute to facilitate subsequent transportation by water; but they themselves also exercise a considerable plucking action (Fig. 28). The work of the avalanche is over in a moment; but during this moment I estimate that it can pluck more earth than the stream in the ravine during an entire year. P. Mougin has measured the amount of material dropped by avalanches in

FIG. 22—Avalanche of Boulangeard d'Oz, Oisans, in the bed of the Eau d'Olle, March 3, 1923. (Photograph by V. Hulin.)

the inhabited valleys of Savoy since the winter of 1907–1908. In four years, that is up to 1912, the total volume of earthy material thus carried amounted to 43,430 cubic meters, in the single year 1909–1910 measuring 23,079 cubic meters. Ground avalanches transported about 79 per cent of the total, and glacial avalanches (which are not included in the present study) about 18 per cent. The avalanche of Blaitière (Chamonix) on April 3, 1914, alone carried more than 2000 cubic meters of earth, rocks, and boulders.

Yet this action must not be exaggerated. Taking an opposite stand from that of Abbé Gex, Professor W. H. Hobbs suggests in a letter dated January 24, 1924, that "the avalanches from hanging valleys into the main U valley would seem to be earlier stages to the slide down of the U walls in successive slices, as for example in the Flimser Bergstürz."[34] I believe that there is here a confusion between the avalanche of snow and the landslide. The erosive action of the former is more modest but is undeniable: the appearance of an avalanche-furrowed slope in summer is convincing enough.

[33] Mougin, Les avalanches en Savoie. See also Allix, Les avalanches de 1922–1923 en Dauphiné, *Géogr. Alpine*, Vol. 11, 1923, pp. 513–527.

[34] W. H. Hobbs: Characteristics of Existing Glaciers, New York, 1911, p. 93.

The avalanche exercises its erosive action from back to front, comparable to that of a carpenter's plane. This is, I believe, the only case in nature of this form of erosion. One sometimes speaks of "gouging" action to describe the sculpturing work of a glacier on the surface over which it travels. Such a comparison is out of date and quite inapplicable to a glacier whose kinetic energy is very feeble;[35] but it is perfectly appropriate to the avalanche, which possesses enormous energy.

Destructive Power of Avalanches

It is curious that in all discussion regarding glacial erosion no physiographer has advanced this simple-enough idea of kinetic energy. It is expressed, as one knows, by the equation $f = \frac{mv^2}{2}$, in which m represents the mass in movement and v the velocity. The advantage of the avalanche, the speed of which is enormous, over the glacier, of much greater mass but insignificant velocity, is obvious.

Attempts have often been made to measure the volume of avalanches. Coaz, Heim, and Mougin give values for the larger avalanches ranging from 150,000 to 1,000,000 cubic meters. P. Denza, cited below, gives as much as 3,000,000 cubic meters for the avalanche that descended at Venaus, Italy, in the spring of 1885. The Service of Bridges and Roads of Grenoble gives the modest estimate of 200,000 cubic meters for the volume of the great avalanche of Roberts de Livet in March, 1923 (Fig. 25). We shall adopt this figure as representing an acceptable average for the greater avalanches. If such a mass should consist of powdery snow it would have a weight of 14,000 tons; old snow would have a weight up to 160,000 tons.

Now, as we have instanced above, these masses are displaced with high velocity. Actual measurements are rare; the figures already mentioned are based on observations by Coaz (1910) and by P. Mougin. I have myself made two such measurements. On May 7, 1922, on the Meije I observed an avalanche of light wet snow that traveled 3.25 kilometers in 74 seconds, that is at a rate of about 160 kilometers an hour. On January 27, 1921, the avalanche of Mollard (Fig. 7*a*) in heavy wet snow traveled 4.8 kilometers of its course in a little less than 6 minutes, that is at a velocity of 48 kilometers an hour. Slope evidently is a very important factor in acceleration or retardation of the rate; in the first case the average slope was 45°; in the second 30°. An average course for a large avalanche measured along the slope may be said to range between 2500 and 4000 meters. That of Mollard was exceptionally long. The corresponding change in level may range from 1500 to 3000 meters.

If it be assumed that a large ground avalanche descends through 2000 meters with a speed of 10 meters a second and mass approximating that of Roberts, its energy can be estimated at about 20,000,000 horse power. If

[35] The great morphological action of a glacier is due to other causes on which I have submitted other hypotheses (Observations sur la sculpture du relief par les glaces, *Comptes Rendus de l'Acad. des Sci.* [*de Paris*], Vol. 174, 1922, pp. 233–235 and 689–691).

the figure of 3,000,000 given for the avalanche of Venaus is correct, the corresponding energy would be 300,000,000 horse power. For comparable effects in other phenomena one has to turn to volcanic eruptions, great landslides, the breaking up of pack ice or icebergs, tidal waves, the breaking of hydraulic dams. The recent catastrophe at the Lake of Gleno in Italy possessed not more than four or five times the energy of the avalanche of Roberts and was apparently inferior in this respect to that of Venaus.

FIG. 23

FIG. 24

FIGS. 23 and 24—Two views of an avalanche in a wood, Val Cluoza, Switzerland. (Photographs from the Swiss Alpine Club.)

Hence the avalanche must be classed as one of the great destructive forces of nature. It is as capricious as a stroke of lightning. On the occasions when the "wind of the avalanche" is added its effects are entirely unpredictable. The flow of snow itself plays strange pranks on man. That disasters are not more frequent is because avalanches generally follow fixed tracks which one has learned to avoid.

The Avalanche Wind

Sometimes the avalanche expends its force on the ground and remains inoffensive, while the column of air displaced by the fall ravages a considerable area. Nothing gives a more vivid idea of the speed and mass of an avalanche than these sudden hurricanes. Naturally it is the powdery avalanches which give rise to the most violent blasts of air because of their exceptionally high speed; in fact, this is generally the form in which this type of avalanche accomplishes its work of destruction. One can take shelter from the flows of snow; it is more difficult to escape the blasts of air so capricious and unpredictable are they. A number of photographs showing the effects of the avalanche wind have been published, the best of them by J. Brocherel. One may see, for instance, the snow plastered with such

violence against a vertical wall as to cover it with a thick crust; or forest trees lopped down by a single blow at a distance of 500 meters from the avalanche itself, reminding one of the forests destroyed by artillery during the war. We have the good fortune to include here a splendid photograph heretofore unpublished, taken by M. Pierre Lory, Figure 11.[36] This devastation was accomplished by the avalanche of La Dauchère, to which reference has already been made. It was the second, or powdery, avalanche that furnished the blast of air. As Figure 10 and the map Figure 7*d* show, the flow of snow turned at right angles down valley. But the blast of air

FIG. 25—A great ground avalanche at Roberts, Livet, Oisans, which crossed a highway. Photograph taken March 16, 1923, fifteen days after the descent. Pedestrians are seen on the temporary road constructed over the avalanche (for a closer view see Figure 27). See Figure 7*b*. (Photograph by A. Allix.)

continued on in a straight line almost completely mowing down the larch forest covering the ridge seen in Figure 11. The hamlet of La Dauchère lies between the current of snow and that of air as between the forks of a Y and thus escaped destruction.

The force of the wind in a ground avalanche is less powerful. P. Mougin goes as far as to deny its existence. Yet on March 3, 1923, the avalanche of Roberts (Fig. 25) turned head over heels a workman who was passing at a distance of more than 50 meters. This man had been knocked down during the war by the blast from a shell, but he gave the palm for violence to the avalanche!

Some reports state that the avalanche wind has been felt at a distance of many kilometers along the valley in which the avalanche falls. This I do not venture to corroborate; it rests on testimony that is always subject

[36] I am especially indebted to my distinguished friend, Pierre Lory, whose advice has been invaluable to me during the fifteen years that I have studied the mountain. Worthy heir of a great name, this celebrated Grenoble geologist has the modesty to leave to others publication of the results of his own work, as in the present instance. All the data regarding the avalanche of La Dauchère are due to him; on it he has published only a short note, the summary of a lecture given before the Société de Statistique de l'Isère, June 13, 1904 (*Bull. Soc. de Statistique du Département de l'Isère*, Series 4, Vol. 8, 1904, pp. 583–584). On the avalanche of La Dauchère see also the Chronique alpine of F. Durtein (Henry Duhamel) in *Le Dauphiné*, April 17, 1904.

to exaggeration. One thing, however, is indisputable: that damage to forests has been accomplished at distances of about one kilometer. Moreover, the avalanche is itself a great enemy of the woods.

The Avalanche and the Forest

The ravines traversed each year by avalanches are naturally denuded. In summer their reddish tracks stand out against the dark green of the forest. The periodic return of the avalanche is an obstacle to the growth

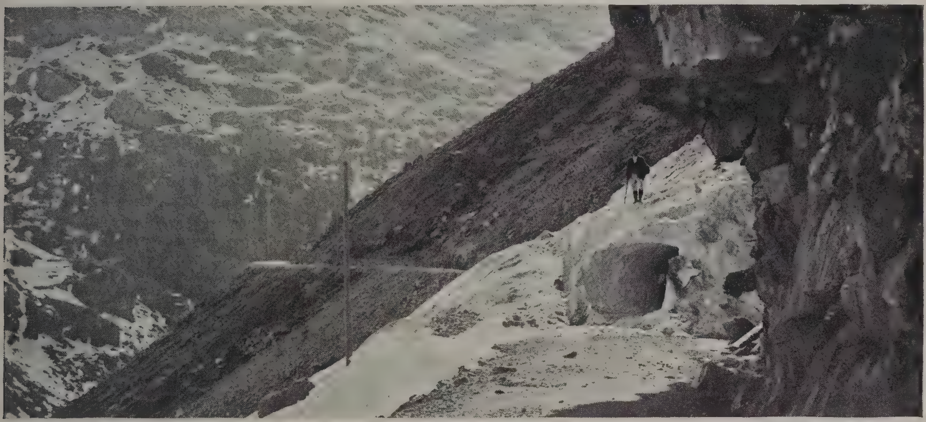

Fig. 26—A tunnel to cross an avalanche in the Pénéon ravine on the road to La Bérarde, St. Christopher-en-Oisans (1600 m.). View in the spring of 1923: at the same date in 1922 this avalanche covered all but a half meter of the telegraph post in the foreground. (Photograph by V. Hulin.)

of trees. An exceptional avalanche or a periodic avalanche turned out of its customary channel will, on the other hand, destroy existing trees. It literally plows up the forest it traverses, beating down the trees and grinding them into pulp. On March 3, 1923, an avalanche that had not descended since 1862 ravaged a forest of sixty-year-old trees in the ravine of Combe Longe on Allemont en Oisans (Fig. 21). The same day in the upper Bréda Valley on the western slope of Belledonne an avalanche that had not come down since 1831 plowed up trees 90 years old (Fig. 28).

It may, however, happen that an avalanche crosses a wood without causing any great damage (Fig. 9). Such is the case where the snow is light and wet, flowing in semiliquid fashion, and where the actions of compression and refreezing are slight. The snow then slips more or less easily between the trees. It may tilt over the trees or they may be broken off at the base or they may even be completely respected when the flow of snow is limited.

The Avalanche and Man

The movements of man in the mountains are liable to be curtailed by avalanches at two points—in the zones of departure and arrival respectively.

It is at the starting point that most of the accidents to alpinists take place,[37] and these have been multiplied since the use of skis has permitted access to the high mountain in winter. In the zone of arrest the chief damage lies in the obstruction of routes of communication. Innumerable examples have been described in the literature, and it is unnecessary to cite new cases; we shall just mention the recent example of the avalanche of Roberts of March 3, 1923, which cut off the entire region of Oisans for 11 days (Figs. 25, 27).

Because of their relative slowness it is rare for ground avalanches to claim victims on the road; such avalanches can almost always be heard and avoided. However, instances are known. In February, 1924, a ground avalanche caught a train full of passengers in the station of Hieflau in Styria before coming to rest in the bed of the Enns. Because of its suddenness the powdery avalanche not infrequently claims victims along the road.

The clearing of a road encumbered by an avalanche always takes a long time because of the hardness of the snow and the compression and congealment that it undergoes. Generally a temporary road is established over the cone using either a trench (Fig. 27) or a tunnel (Fig. 26).

Since the development of hydro-electric power in the Alps a new sort of damage is to be apprehended from avalanches. Fallen masses of snow obstruct the intake channels as well as natural watercourses and for a longer time because of the geometrical section of the channels and their lesser gradient. Stoppage of water alone would not be so serious as the damage done to the installations, which may put the plants out of commission for several days (Fig. 28). A still more frequent accident is the breaking of the transmission wires: during the winter of 1922–1923 both in Savoy and Dauphiny a great number of producing plants were subjected to interruptions of from one to four days. All Lower Dauphiny had its electricity cut off by the avalanche of Roberts. These accidents coincide with the season when the hydro-electric industry is already hampered by scarcity of water.

Falling in winter or at the beginning of spring the avalanche naturally has no effect on agriculture except indirectly by the covering of ground with snow and by the purely local lowering of temperature already discussed. But in exceptional cases the fall of snow causes direct disasters to the human inhabitants of the mountains. Mountain villages avoid the usual tracks of avalanches. Accidents to settlements are only likely to occur under three conditions. In the first instance, a flow may be exceptionally long, reaching a point believed safe (Figs. 29, 30). In the second case, a flow may be diverted from its normal channel, this having been filled with snow by a preceding avalanche, as happened many times in 1922–1923 in Dauphiny. Or thirdly, a new avalanche may occur on a slope believed safe (see Figs. 13, 32, 33).

[37] On this subject there exists a special literature. See the works of Rutgers and Hess (the latter very complete) and the list of accidents periodically published by the various Alpine Clubs. There is a family resemblance between oral accounts of avalanches and fishing stories, and it is well to take them with a grain of salt.

FIG. 27

FIG. 28

FIG. 27—Temporary road across the avalanche of Roberts during the obstruction of the highroad and the railroad 30 meters below. Compare Fig. 25. The lumps of snow composing the avalanche are very distinct. Another smaller avalanche may be seen in the background on the other side of the valley. View four days after descent of avalanche. (Photograph by V. Hulin.)

FIG. 28—Intake channel of a hydro-electric plant obstructed by a ground avalanche loaded with earth and trees. Upper valley of the Bréda, Dauphiné, March, 1923. (Photograph by V. Hulin.)

Fig. 29

Fig. 30

Fig. 31

The hard snow carried by the avalanche is not contented with knocking over the houses, often it fills them, a circumstance that renders the work of rescue the more difficult. As in a mine accident, the exact spot where the victims are entombed must be known. This is difficult because, while they can hear perfectly the voices of the rescuers, they cannot make themselves heard. Coaz and Brocherel have recounted many tragic stories relating thereto.

Statistics of Avalanches

Attention has been called to the dangers of avalanches as far back as records of the mountain country have been in existence. Fifteenth century texts, such as the chart of Henry VI of England on the Great St. Bernard Pass in 1422, have been described.[38] As a text of 1475 shows, the cutting of the first Alpine tunnel, that of the pass of Traversette at the end of the fifteenth century, was undertaken to afford protection from avalanches. I have recently found still more ancient texts relative to the avalanches of Dauphiny (Oisans) at the beginning of the fourteenth century.[39]

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[38] Brocherel, *op. cit.;* Coaz, Die Lawinen.

[39] See some recent texts in Étienne Clouzot; L'enneigement dans le Queyras aux XVII[e] et XVIII[e] siècles, *La Géographie*, Vol. 31, 1916–17, pp. 252–260.

Figs. 29 and 30—A house of Allemont, Oisans, that narrowly escaped destruction by the avalanche of Combe-Gibert, March 3, 1923. Figure 29, view from above looking towards the snow-covered plain of the Eau d'Olle; Figure 30, a side view, shows the avalanche charged with earthy and woody débris. (Photographs by V. Hulin.)

Fig. 31—House at Brévières, Tarentaise, Savoie, overthrown and filled with snow, February 12, 1881. (Photograph by Allotte de la Fuye and Jager.)

Fairly complete lists for the last three centuries have been drawn up by Dr. Coaz for Switzerland and P. Mougin for France. Unfortunately Mougin's tables only deal with Savoy (Departments Savoie and Haute Savoie with Mont Blanc). There is nothing for Dauphiny and the Pyrenees save some isolated articles. Similarly for Italy and Austria and other

FIG. 32

FIG. 33

FIGS. 32 and 33—A house of La Rivoire, Oisans, destroyed by the avalanche of March 3, 1923. Compare Figures 13, 19, and 20. Figure 32 was taken fifteen days after the descent. A cross marks the site of the house, and the arrow points to the spot whence Figure 33 was taken, six months later (Sept. 16).

mountain massifs as far as I know.[40] Here is a gap in geographical documentation waiting to be filled.

Statistics prove the truth of popular observation that avalanches tend to follow the same tracks. Sometimes they only descend two or three times a century; most commonly they are annual but then of rather limited dimensions; at variable intervals they may take on catastrophic propor-

[40] Brocherel, *op. cit.;* Hess, *op. cit.* See several notes by P. F. Denza in *Riv. Mensile Club Alpino Italiano,* Vols. 4 (1885) to 7 (1888), especially "Le valanghe dell' inverno 1888," Vol. 7, 1888, pp. 134–137.

tions. The avalanche Roberts, for example (Figs. 7*b* and 25), is annual; it generally comes to rest as a tongue in its ravine; but three times in 30 years it has reached the road and the river in the form of a big cone—in 1893,[41] in 1908, and in 1923.

Colored maps showing the tracks of annual avalanches have been prepared by Coaz for Switzerland and by Mougin for Savoy. In these maps the mountains are striped zebra-like. For Switzerland Coaz shows 9368

FIG. 34—Protective works against avalanches. Wooden fencing and reforestation below the tree line in Valais. (Photograph by J. Brocherel.)

tracks; Mougin 1361 for Savoy. Dauphiny would show at least as many. These figures include only the exceptional avalanches that descend into and devastate the inhabited zone, and the number would be infinitely greater if inclusion were made of the little avalanches so frequent on the high mountains above the tree line. On the map, Figure 7, I have attempted to show the two types of occurrence for a valley of Oisans in the spring of 1923.

The most terrible catastrophes of which history makes mention have occurred in the Swiss Alps. That of Louèche in Valais in 1719 wiped out the town, killing 60 persons; that of Obergestelen in 1720 destroyed 120 houses and killed 80 persons and 400 head of cattle; that of Saas in Grisons in 1689 wiped out place and people. In Italy the greatest catastrophes were those of 1885: in Exilles the avalanche of Deveis destroyed 16 houses and buried 62 persons, of whom 35 died; that of Frassino in the Val Varsita

[41] Pierre Lory: L'avalanche de Livet, *Trav. Lab. Géol. Univ. Grenoble*, Vol. 3, 1893, p. 283.

FIG. 35

FIG. 36

FIGS. 35 and 36—Protective works against avalanches. The use of stone fencing above the tree line. Figure 35 at Chantelouvre, Dauphiné; Figure 36 in Valjonffrey, Dauphiné. (Photographs by V. Hulin.)

killed 70 persons. In 1888 great new avalanches accounted for 145 victims in the Italian Alps.

I have elsewhere described the catastrophes of 1447 and 1450 at Ornon and Venosc in the French Alps, the first of which razed the hamlet of Poutuire and killed 14 persons, the second killing 5 persons and 75 head of cattle. In 1681 at Abrier in Queyras 57 houses were demolished and 11 persons were killed. Mougin's statistics record avalanches of two successive winters at La Giettaz at the foot of the pass of Aravis in 1843 and 1844; the first engulfed 8 houses and killed 14 persons; the second engulfed 8 more houses and 13 persons, of whom 6 died. On February 12, 1881, 14 houses were destroyed at Brévières, 37 persons being involved, of whom 9 succumbed. Reference has already been made to the casualties of 1923.

Protection against Avalanches

Such figures go to show that money expended in works of protection against avalanches is well spent. Study of works of this nature has been pushed far by the Forest Service of Switzerland since the middle of the eighteenth century and by that of France since the beginning of the nineteenth.[42] Protective works can be divided into two classes, which, following medical terminology, I term "preventive" and "curative." The latter consist in devices to restrict the destructive power of avalanches and includes the building of strong masonry walls in the shape of plowshares. In Switzerland artificial channels in stonework have been built to carry off the torrent of snow as for a too turbulent torrent of water. This method, however, seems to me inefficient because of the disproportion between the cost of erection and its eventual usefulness where an enormous volume of snow has to be contended with.

Preventive methods aim at prohibiting formation of the avalanche, that is at retaining the snow on the high slopes. For this wooden or stone fences, according to proximity and cost of material, have been commonly employed: however, I would suggest substitution in the latter cases of a more continuous metal trellis work (Fig. 35). The Forest Service has long advocated reforestation of the high slopes wherever feasible. It is not a new idea. Some among the oldest texts that I have found on avalanches in Dauphiny (fourteenth century) relate to forest administration and mention avalanches as one of the reasons for afforestation. Now avalanches may start from above or below the tree line. According to Mougin's figures about two-thirds of the ground avalanches and about half of the other avalanches start below tree line. This gives a theoretical measure of efficiency to be expected from afforestation as a means of suppression of avalanches. Reforestation is most often combined with a system of fences, at least at the beginning for the protection of the young growth (Fig. 34).

[42] Details in the works cited, Coaz and Hulin. More recent details and bibliography in the study of P. Mougin, Les avalanches en Savoie. Photographs in the article by Brocherel, *op. cit.* See also André Allix: Peut-on prévoir et empecher les avalanches? *Le Petit Dauphinois*, Grenoble, May 28, 1924.

Beyond the starting point it is of course obvious that no forest will stop an avalanche.

Prediction of Avalanches

Contrariwise to the question of protection little has been done towards prediction of avalanches.[43] In the first instance it must be pointed out that there can be no thought of forecasting the precise moment of release of an avalanche. The only observers qualified to speak on this matter, alpinists and ski runners, have all been impressed by the suddenness of the occurrence. To the observations of my predecessors I will add only two personal experiences; one on skis in Vercors on February 2, 1913; the other in Oisans on April 29, 1919. The most skillful cannot escape.[44] We may also refer to Mallory's experience on Mt. Everest, June 7, 1922, when his party was overwhelmed and seven porters killed:[45] "We were startled by an ominous sound, sharp, arresting, violent, and yet somehow soft like an explosion of untamped gunpowder. I had never before on a mountainside heard such a sound; but all of us, I imagine, knew instinctively what it meant, as though we had been accustomed to hear it every day of our lives. In a moment I observed the surface of the snow broken and puckered where it had been even for a few yards to the right of me. . . And then I began to move slowly downwards, inevitably carried on the whole moving surface by a force I was utterly powerless to resist."

Yet the native mountaineer is distinguished from the city-bred amateur by a certain instinct in regard to the occurrence of avalanches. The great majority of accidents of this kind happen to parties unaccompanied by a guide. Chamois hunters and professional guides are rarely caught. But it is impossible to give any rules about the release of avalanches, and the only advice of experts is that of Dr. Hoek: "Prudence, prudence, prudence: keep the rope in the knapsack, and distances well spaced."[46] Since the observations of Dr. Coaz many others have described the trifling causes that may start an avalanche; besides the passage of a party of individuals, a slight shaking of the ground, the sounding of a distant train, bells of the flocks, cries or shouts of passers-by. A wonderful observer of alpine nature, the late David Martin, himself a mountain peasant, tells how the children of Valgaudemar amuse themselves in winter by provoking miniature avalanches that they may slide down on them.[47]

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[43] André Allix: Sur la prévision des avalanches, *Comptes Rendus de l'Acad. des Sci.* [*de Paris*], Vol. 178, 1924, pp. 1831–1833.

[44] Among the many descriptions of this kind of accident I would mention those of A. de Quervain, *op. cit.;* J. I. Clark: An Avalanche Experience on Ben Achalladar, *Scottish Mountaineering Club Journ.*, Vol. 10, 1908–09, pp. 346–348.

[45] C. G. Bruce and Others: The Assault on Mount Everest, 1922, London, 1923, p. 282. See also André Allix: Les enseignments du Mont Everest, *Rev. de Géogr. Alpine*, Vol. 12, 1924, pp. 99–128; references on pp. 122 and 127.

[46] Use of the rope, invaluable on the glacier, is here extremely dangerous. Mrs. Clark (*op. cit.*) has described this in a fatal experience. The necessity of keeping far apart explains itself; one might further add the advice of following in separate tracks instead of Indian file, in order to avoid cutting the snow: as we have seen, it is the notch of the track which is the chief cause of the sliding of the snow board.

[47] *Le Courrier des Alpes*, Grenoble, March 17, 1904; information supplied by P. Lory.

Several avalanches may start almost simultaneously from the same point. Charles Rabot mentions an example that happened on February 4, 1897, on the Little St. Bernard, when the provisioning convoy of a military post was struck in succession by two death-dealing avalanches. Maurice Paillon, at the same period, saw avalanches succeed each other without interruption for 36 hours in the valley of Vénéon in Oisans with a roar comparable to that of a train in a tunnel.

There are, however, critical periods during which avalanches are particularly to be feared. At such time the snow is in a position that I have called subequilibrium (*sous-équilibre*),[48] analogous to what physicists know as the state of subliquefaction below the point of solidification. One knows that in this case solidification of the liquid may be effected by the introduction of some exciting factor, small though it be in itself. In the state of subequilibrium the snow is not merely in unstable equilibrium, but in an equilibrium already broken theoretically. In this state a slight exciting factor will make it begin to slide. Thus a most insignificant cause may give rise to a result as formidable as the avalanche.

Now in the matter of prediction of avalanches the most one can hope to obtain is the determination of this state of subequilibrium indicating the liability to accidents at critical periods. The immediate causes of release will always escape prevision; one can only avoid those provoked by human agency at critical periods.

There are two ways of determining the critical periods. The first, purely theoretical, is founded on the state of the snow and the application of certain mathematical formulae. Its application, however, is impracticable for lack of sufficient competent observers permanently located in the high mountain regions. The second method, which I advocate, is purely empirical. It consists in determining for a sufficient number of years the meteorological characteristics of the periods that precede the starting of avalanches by means of daily observations taken at average altitudes in all the mountain regions. In 8 or 10 years one would be in possession of "probability" tables likely to be of great service.

Figure 37 furnishes examples of observations of this nature applied to the French Alps. Graph *a* shows, contrary to a widely held opinion, that it is not the quantity of snow alone which provokes avalanches. At Bourg d'Oisans in 1922–1923, the place and period to which they refer, there fell hardly more than the average of snow. But this snow was distributed in a special fashion. In December the quantity was exceptional and alone would explain the occurrence of avalanches; in February, when it was less than the average, other causes must have been in operation.

Graph *b* is simply the juxtaposition on the same diagram of data furnished by Mougin for regions of Savoy between 500 and 1000 meters in altitude. It is surprising that he did not himself think of bringing together the sets of observations and drawing conclusions therefrom. The maximum

[48] *Rev. de Géogr. Alpine*, Vol. 11, 1923, p. 803.

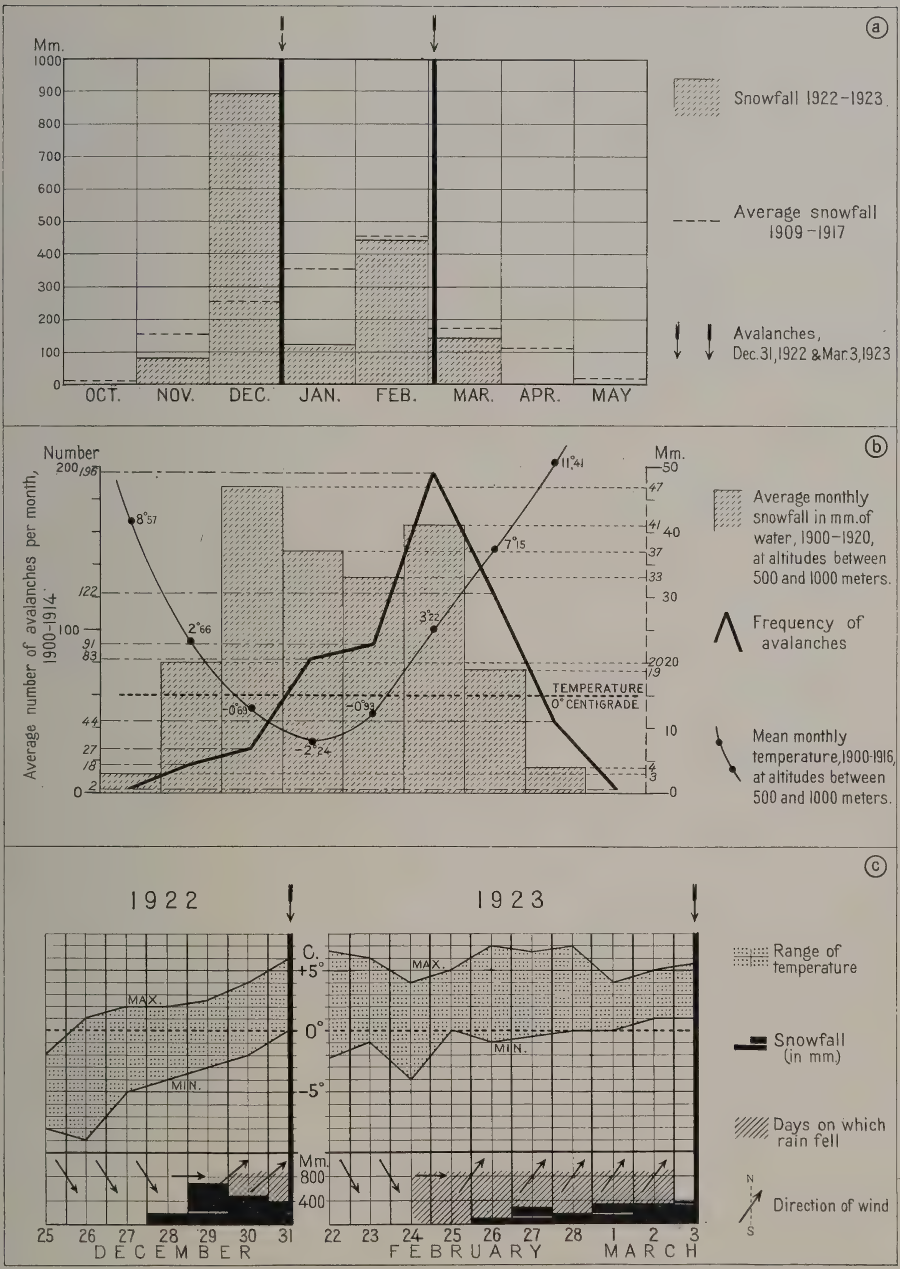

FIG. 37—Graphs illustrating researches on the prevision of avalanches (*Comptes Rendus de l'Acad. des Sci.*, 1924). Graph *a* shows the snowfall of the winter 1922–1923 compared with the average of eight years and relation with avalanches.

Graph *b* shows relations between the mean snowfall, mean monthly temperatures, and frequency of avalanches in Savoy.

Graph *c* shows meteorological conditions on the eve of the great avalanches of December 31, 1922, and March 3, 1923, in Oisans. (Data from Bourg d'Oisans.)

number of avalanches in March does not coincide with the maximum fall of snow in December: they become most frequent when the mean monthly temperature rises. To clinch the argument I have drawn Graph *c*, which visualizes the meteorological data for the critical periods of 1922–1923 in Oisans.[49] It appears that in the two cases the great avalanches start after a marked rise in temperature accompanied by fall of soft snow and a southwest wind. The cases studied are those of warm avalanches; work on cold avalanches remains to be begun. It will confirm the empirical observation that reduction in temperature here plays a part. It is probably this observation that Dufour echoes in a vague memorandum of 1878, the only work which, to my knowledge, has been specially devoted to the subject of prediction of avalanches.[50]

I do not claim to be the first to have studied the actual meteorological conditions of critical periods. Von Ficker has discussed the rôle of the föhn. Rütgers, notably, has given meteorological tables for certain Swiss avalanches, and he counsels ski runners always to furnish themselves with a thermometer. Maurice Paillon has given many observations in the periodicals of the French Alpine Club. But I emphasize the value of developing the method systematically upon strictly defined bases (pressure, winds, temperature, precipitation) to obtain in time true forecasting tables. Only probabilities for the detachment of avalanches at critical periods can be foreseen; the actual release rests on fortuitous causes. These phenomena, like meteorological storms, will always contain an unpredictable element. Furthermore, it should be noted that avalanches, like storms, are essentially local phenomena. The tables of Coaz and Mougin show this clearly enough. A year poor as a whole in great avalanches will yet show 7 or 8 or 10 considerable occurrences along the same valley, even on the territory of a single commune, whilst in neighboring regions they are few in number or limited to the usual small annual avalanches. This was instanced in the French Alps in 1923. In lower and central Oisans on March 3, 1923, between 4 and 5 o'clock in the morning there fell more than 100 avalanches, 10 of catastrophic dimensions. The same year in the Prealps and even in upper Oisans avalanches were below the average in number. Thus it is desirable to establish as extensive and dense a network of observations as possible for the forecasting tables.

With the hope of rendering practical service by the establishment of a method of prediction I leave the avalanche, a characteristic phenomena of the mountain, an occurrence that has been known and dreaded since man inhabited the mountain, and one which must be classed among the most powerful forces of nature.

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[49] Allix, Les avalanches de 1922–1923 en Dauphiné, *Rev. de Géogr. Alpine,* Vol. 11, 1923, p. 526.

[50] C. Dufour: Sur la chute des avalanches, *Comptes Rendus de l'Acad. des Sci.* [*de Paris*], Vol. 87, 1878, p. 307.

NATURAL REGIONS OF CZECHOSLOVAKIA

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Czechoslovakia occupies a comparatively small area—it is not much larger than the state of New York—but therein is displayed the greatest variety of landscape. Side by side lie plains and mountains of various types; primeval forests and mining and manufacturing centers; rich plowland and high mountain pasture; mushroom towns of today and ancient cities now preoccupied with dreams of bygone glories.[1] This manifoldness, this changing of aspect almost at every step is a characteristic feature of the country. Another distinguishing feature is bound up with its situation.

For good reasons the Czechoslovakian republic has been called the heart of Europe. Though as regards area the center of Europe lies somewhat farther to the northeast, the center of population is approximately in the border region between Bohemia and Moravia. Czechoslovakia is situated on the threshold between the densely populated west and the sparsely inhabited east. This question of situation is of such fundamental importance that we shall examine it first.

Anterior Europe, as we may term that part of the European mainland west of a line running from the mouth of the Vistula (Weichsel) to that of the Danube, is crossed by two belts of mountains. From the Ardennes to the Bohemian massif we find an interrupted row of irregularly shaped fault-block mountains, remnants of a once continuous peneplain. From the Gulf of Genoa a great mountain arc, comprised by Alps and Carpathians, runs roughly northeast and eastwards. Where the Danube cuts across the arc it truncates obliquely the row of fault-block mountains. Between the two mountain systems, as well as north of the fault-block mountains and within the Alpino-Carpathian arc, lowlands border the foot of the highlands. The central forelands of the Alpine system and the German lowlands of the great European plain merge into each other where the fault-block series discontinues. The central lowland belongs to the Danube basin and thus makes connection with the southern, Pannonian lowlands. Now the meridional axis of Czechoslovakia lies just in the central lowland, between the Bohemian massif and the Carpathian section of the arc which here projects northward—that is where one barrier gives out and the other is pierced in a structurally weak (faulted and less elevated) spot by the Danube. In other words, Czechoslovakia is situated where the European

[1] For general accounts of the Czechoslovakian state and its people see Emmanuel de Martonne: L'État tchécoslovaque, *Ann. de Géogr.*, Vol. 29, 1920, pp. 161–181; M. S. Stanoyevich: Czecho-Slovakia and Its People, *Geogr. Rev.*, Vol. 8, 1919, pp. 31–36.

FIG. 1—Relief and regions of Czechoslovakia. The relief map is a photograph of a model with the addition of place names. Numbers on the regional map have reference thus: 1, border mountains (crystalline) of the Bohemian massif; 2, basins (Permo carboniferous and Cainzoic) of repeated down-faulting and weak rocks; 3, Tertiary volcanic regions; 4, Cretaceous table-land; 5, central and Bohemo-Moravian peneplain with chief monadnocks; 6, Flysch zone; 7, first Carpathian massif zone; 8, second massif zone; 9, third massif zone. Scale of the regional map 1: 7,000,000.

continental divide crosses a continuous lowland tract; and it thus is the natural center of through traffic in Europe.

The Fundamental Regional Division

The Bohemian massif to the west, the Carpathian ranges to the east of the meridional lowland belt are the two main subdivisions of Czechoslovakia. The first is the basin of the Vltava-Labe, the upper Elbe with its chief tributary, the Moldau. The Carpathian ranges and the lowlands to the west and south of them pertain with but insignificant exceptions to the Danubian system. Added to this hydrographic distinction is difference in structure and morphological development.

In the Bohemian massif the trend of the relief is almost entirely due to faulting and warping. In the northeast and southwest a northwest-southeast trend prevails, the two other sides being characterized by dislocations at right angles, giving a northeast-southwest trend. Upon the whole, these disturbances have resulted in an uplift of the border regions, hence the well-defined quadrilateral basin of Bohemia.

The rocks of the massif are on the whole resistant. Weak rocks are restricted to structural basins of a local character, and here the rivers have excavated broad lowlands, often bordered by fault scarps and flexures. Otherwise even the main rivers have barely reached the mature stage. Their present valleys, bordered by several sets of terraces, are sunk deeply into an uplifted peneplain, the uplift being more pronounced towards the borders (Fig. 2). Monadnocks of specially resistant rocks rise some 100 to 200 meters above the peneplain. They either form long ridges, following the strike of folded rocks, or are circular in arrangement, representing the metamorphosed rim of laccolithic intrusions.

In the Carpathian region, on the other hand, a zonal arrangement prevails both as regards structure and distribution of the various kinds of rocks. The outer zone is represented by the sandstones and slaty marls of the so-called Flysch. Within may be distinguished three zones of massifs, separated from the Flysch and from one another by strings of basins. The crystalline core of each massif is more or less mantled by limestones (Mesozoic), giving rise to karstic phenomena. In the south these massifs are partly covered by young volcanoes. Farther east the zone of massifs disappears, and a strip of lowland separates the Flysch mountains from a volcanic range.

While we contrast the faulted structure of the Bohemian massif with the young folded structure of the Carpathians, it must not be overlooked that even in the Carpathian Mountains the existing land forms are dependent primarily on uplift and faulting and not on the previous folding, young though it is, geologically speaking. Whether the area was ever peneplaned as a whole is still open to question. Yet unmistakably old land forms, traces of a far more advanced cycle of erosion, are to be found on the summit

level of the mountains. The rivers also are antecedent to the down-faulting of the intramontane basins. In young valleys, along which series of rock terraces at high levels may be traced, the rivers cross the barriers not only between two neighboring basins but even the massifs between outer and inner basins.

Another distinction due to the different stage of the physiographic cycle in the two regions rests in the difference of elevation. The central portion of the Bohemian peneplain lies at an elevation of approximately 500 meters with monadnocks rising 300 meters above it, the valley bottoms being only some 100 to 200 meters above sea level. Towards the sides of the Bohemian square the peneplain is warped up, reaching altitudes of 1000 to 1300 meters in the frontier mountains: it is only towards the southeast that this warping is less marked, the border along the Moravian corridor seldom exceeding 600 meters above sea level. In the Carpathians orogenic forces are far more in evidence. The elevation at which traces of the old land forms may be found often exceeds 2000 meters, the Gerlach pinnacle in the High Tatra rising to 2663 meters. This elevation is due to later crustal movements and does not represent the original elevation at which the land forms in question were developed, for until almost recent geological times the Carpathians were islands and peninsulas of seas and lakes in which sedimentation was in progress and round which may be traced shore-line terraces up to 500 meters and more above the present sea level.

The present land forms of both the Bohemian massif and the Carpathians were initiated by faulting and uplift, after the formation of a peneplain in the west, of subdued land forms in the east. But in the east the uplift was stronger, and the structure produced by folding is not yet obliterated by the younger fault structure.

Influence on Human Life

Human life reflects these conditions. The west is a region of flourishing manufacture. Large towns developed in the basins, the soft rocks of which contain rich resources of coal and lignite. Sheltered from the cold northern and rainy western winds they have a warm dry climate, yet with sufficient rainfall to permit the growing of cereals and beets. On a great thoroughfare from west to east, this section of Czechoslovakia gravitates towards the Atlantic. From early days it has been one of the most advanced centers of western civilization. Of the primitive landscape but little has survived. Fields of corn crops, sugar beets, cabbages, and potatoes have supplanted the former grassy steppes of the lowlands, the former woods of the mountains. Only the steep sides of young valleys and fault-line scarps are still forested to a considerable extent. The average density of population is 128 per square kilometer.

The Carpathians offered their early inhabitants shelter against the warlike, once nomadic, peoples of the Pannonian steppes. Only the intra-

FIG. 2

FIG. 3

FIG. 2—The Vltava (Moldau) south of Prague. An incised valley characteristic of the Bohemian massif; the peneplain in the background. (Photograph by Professor Radim Kettner.)

FIG. 3—In the Krkňose (Giant Mountains), the uplifted peneplain of the northeastern border of Bohemia. The lake-filled cirque of the Malý rybník (small fishpond) in the foreground. (Photograph by Professor Vitásek.)

montane basins are habitable. Here people cluster into small towns and large villages. Here, up to altitudes of sometimes more than 800 meters, arable soil is to be found, though there is always the threat of inundation when the snow melts in the mountains and torrents descend from their narrow ravines onto the level bottom of the basins. Lumbering is one of the chief occupations, and sheep raising rules life on the mountain pastures above the limit of forests, that is at an elevation of from 1300 to 1400 meters. The average population density of the whole region is but 57.

The influence of the orographic features on the development of communications is clearly exhibited. The roads of the Bohemian basin have been centered practically since prehistoric times on the site of Prague, where most of the larger rivers converge, though the former roads avoided the narrow deeply incised valleys, reaching the high-level plain by mounting the more gently inclined slopes of meander spurs.[2] The railroads prefer the valley bottoms, crossing the spurs by tunnels and using the alluvial flats developed now on the right, now on the left bank of the river. Therefore with the development of railroads a valleyward movement of the population set in. This applies especially to the valley of the Beroun, where limestone quarries opened in the folded Devonian limestones and the establishment of huge cement works created populous settlements.

In the Carpathian Mountains there exists no such natural center of communication. The main lines of traffic branch out from the Moravian corridor and cut through the Flysch belt by following transverse valleys. There valleys are always threatened by landslides; for the slopes are still being undercut by erosion, and the lithological nature of the formation—alternation of clays and sandstones—favors the tendency to slide. Within the Carpathian arc also the railroads follow the course of the rivers, passing from one basin to the next. Each small basin has its own center, all of them growing under the influence of the railroads, but no one showing signs of becoming all-important for the whole region.

The Bohemian Massif[3]

Northwestern Bohemia may be described as a broad arch, the keystone of which was down-faulted. The up-warped peneplain slopes gently towards the interior of Bohemia to the Cisařský Les (Imperial Forest) and towards Saxony in the Krušné Hory (Ore Mountains), but both these mountains turn a steep slope towards each other, at higher levels representing a much dissected fault scarp, farther down a young, nearly undissected fault-line scarp. These two features of the slopes are of different morphological age, but they may be due to the same faulting; or the mor-

[2] For details of the site of Prague see the author's paper, "Prague: A Geographical Sketch of the Town," *Geografiska Annaler*, Vol. 2, 1920, pp. 67–79.

[3] See also the author's paper "Les régions morphologiques du massif bohémien," *Ann. de Géogr.*, Vol. 32, 1923, pp. 41–57.

FIG. 4

FIG. 5

FIG. 4—Český Krumlov, an old town on the Vltava, in the spurs of the Šumava (Bohemian Forest).

FIG. 5—The Hrubá Skála (rough rocks) near Tumov in northern Bohemia. Topographic forms in the sandstone (Cretaceous) region of the Sudetic foothills. In the background the basaltic neck and crowning ruins of Trosky.

phologically young, lower part of the slopes may even be the geologically older one. For with the down-faulting sedimentation set in all over the down-faulted trough of the Ohře (Eger) basin, a thick mantle of sediments protecting the lower parts of the slopes against denudation until a new regional uplift revived river erosion.

Volcanic eruptions went hand in hand with the orogenic movements; the Domed Mountains (Středohoři) on both sides of the Labe, now base-leveled and faulted, and the Mountains of Doupov, crossed by the Ohře in a picturesque valley below Karlovy Vary (Carlsbad), are the largest of the volcanic remnants of Northwestern Bohemia. The last phenomena of volcanic activity still exist in the form of the numerous mineral and thermal springs, of which those of Karlovy Vary (Carlsbad) are the best known.

As the name "Ore Mountains" implies, the region is rich in minerals, ores of silver, copper, tungsten, etc., occurring in the contact zone between the crystalline schists and the granitic laccolites. For long the chief industry of the region was mining. At a later period, when the chief lodes were exhausted and mining no longer paid, a state of overpopulation obtained in the mountain region. Home industries were developed, poorly paid though these are, and remarkable skill in the making of all kinds of laces, wooden toys, and musical instruments has been acquired. There also set in a movement of migration downward into the basin of the Ohře, where lignites and fine china clay have given rise to a flourishing ceramic industry. More recently mining in the mountains has been revived, notably with the discovery at Jáchymov of pitchblende rich in uranium.

Northeastern Bohemia is the region of the Sudetic ranges. Here, too, the peneplain was warped up; but the keystone of the geanticline here still represents the highest part, facing with steep fault scarps the interior of Bohemia as well as the Silesian plain. The Sudetic Mountains might be described as more or less trunk-shaped. They are crossed by longitudinal and transverse faults, along which the blocks were moved differentially. The dominant block is that of the Krkonoše (Goat's Ridge, sometimes also called the Giant Mountains), rising in the Sněžka (Snow Dome, though rather pinnacled in shape) to 1603 meters. During the Ice Age this part of the Sudetic Mountains suffered glaciation of the Norwegian type; and the level, moor-covered fjeld presents a marked contrast to the steep sides of the cirques and the overdeepened valleys below (Fig. 3).

For man these mountains had little to offer. It is only in the valleys that one finds industries developed, linen weaving and paper making, using for the manufacturing processes the clear waters of the mountain streams as well as power from the rapids.

Southwestern Bohemia is the land of the Šumava (Bohemian Forest). These mountains may be considered to be residuals surviving from the former watershed of the great Bohemian peneplain, yet at the same time their summit level suggests the existence of an older peneplain, sloping

down towards the northeast. The central Bohemian monadnocks of the Brdy seem to be capped by this old peneplain, and near Prague it is seen to dip below the denuded edge of unfolded, almost undisturbed Cretaceous beds. The Bohemian Forest is the largest wooded area of Bohemia; and much wood is rafted down on the Vltava (Moldau), which here has its source.

Like the Bohemian Forest, the Bohemo-Moravian border region in the southeast is one of the least populated parts of Bohemia, the average density falling to 30. The general altitude does not exceed 600 meters, but the soil, derived from crystalline schists, is poor, the region exposed—it is called, though with much exaggeration, the "Bohemian Siberia." It offers no difficulties to transit and is crossed by numerous lines of traffic but by no important one such as might possibly stimulate the growth of towns along it.

The largest town of southern Bohemia, Budějovice (Budweis), is situated in the angle between the northwestward-trending Šumava and the northeastward-trending Bohemo-Moravian border regions, in a small downfaulted basin. Its origin as a prehistoric site may be traced to the impermeable clays that permitted the construction of fishponds.

The center of Bohemia is the pivot of the region, whether regarded geologically, economically, or historically. West of Prague coal is mined in the districts of Kladno and Plzeň (Pilsen). Rich iron ores, limestones, kaolin, and various brick clays occur in the immediate vicinity; hence the coal basins represent one of the chief manufacturing centers of Czechoslovakia. North of Prague we enter the region covered by Cretaceous rocks but slightly disturbed. On the border of the old lands, represented by the crystalline rocks of the Sudetic Mountains, sandstones dominate, often rising in weird shapes and covered by heath and dark pine forests. Here in the region of woods and arenaceous quartz lies the chief center of the celebrated Bohemian glass industry. Farther south fertile marls prevail or a superficial covering of loess. These lowlands along the Labe north of Prague are the Bohemian paradise, where wheat and sugar beet, the famous Bohemian barley and hop, the vine, and other fruits thrive. Manufacturing is here connected with agriculture, which not only furnishes the raw material but also the necessary labor. When the harvest is over, the season for the factories begins, providing work for the winter months. Truly a paradise, where work in the open air and in the factories alternates, giving opportunity for acquisition of health and wealth and without the drawbacks nearly always connected with manufacturing districts in the vicinity of a coal field.

The Moravian Corridor

In the east the Bohemian massif is bordered by the lowland belt of the Moravian corridor. In time almost recent geologically the corridor was occupied by a sea, which has left its mark not only in the sediments of the

lowlands but also in marine beaches and platforms of abrasion along the border of the massif as well as along that of the Carpathians. As the sea washed the shores of a peneplain in the west, in the east a land of dissected mountains, the two shore lines are rather dissimilar. In the west the old shore line runs almost straight, in the east the sea invaded the valleys in long narrow gulfs. Isolated hills rise above the lowland; they are the summits of down-faulted mountain ranges, once connecting the Alpine and Carpathian sections of the arc. Though isolated and of slight elevation, some 500 meters, they yet protect the southern part of the lowland against the cold northers, and here the same economic conditions prevail as in the central Bohemian plain. Farther to the north the climate is more severe, and stock raising assumes more importance. Then suddenly the scenery changes. Dark smoke clouds hang over the landscape, heaps of slag disfigure the ground, a hundred towering chimneys proclaim the entry into the manufacturing region of the Ostrava coal field, the chief coal district of Czechoslovakia, situated just on the frontier and forming the southern edge of the Upper Silesian coal field (Fig. 6). The Ostrava conurbation is far more populous than even the principal town of Moravia, Brno (Brünn).

Brno lies within the massif, where several rivers unite before crossing its border towards the lowland. Sheep farming on the mountain heights; small coal fields west of Brno which, lying in a narrow down-fault trough, escaped denudation; and the occurrence of various clays have made of Brno a manufacturing center, with a woollen manufacture celebrated from of old and a stove-manufacturing industry that sprang from the making of Dutch tiles. Though less important than Prague (676,476), Brno (221,422) excels it by far in the beauties of its surroundings. North of Brno lies the wonderland of the Moravian Karst with its stalactite caves in Devonian limestones; and in the east, beyond the lowland, the blue ridge of the Carpathians borders the horizon.

The Carpathian Arc

Within the Carpathian region of Czechoslovakia two main subdivisions may be distinguished. In the west is Slovakia, where small basins alternate with mountain groups. In the east is one large basin, the Marmaroš, where the upper Tisa gathers its waters, the center of Carpathian Ruthenia (Podkarpatská Rus). Between these two regions the Prešov-Košice (Eperies-Kassa) corridor runs northward to the Flysch range, where low gaps, only some 500 meters in elevation, act as gateways.

This Flysch zone, representing the northernmost or outer range, is the most continuous of all the Carpathian zones for it stretches far into Rumania. Permanent settlements are to be found in the valleys, the mountains being frequented only by woodmen and seminomadic shepherds. The same is the case with the massifs of Slovakia, composed of granites, crys-

FIG. 6

FIG. 7

FIG. 6—Vítkovice, a typical mushroom town in the mining and manufacturing region of Ostrava, on the Moravo-Silesian border.

FIG. 7—Kremnica, an old mining town in the volcanic mountains of southern Slovakia.

talline schists, and Mesozoic limestones, all intensely folded and fractured, rich in mineral and thermal waters, and not improbably far richer in ores than the comparatively few mines already opened would indicate. Where the mountains border on the basins numerous quarries have been opened, but traffic is still too poor to make quarrying pay farther in the interior. The loftiest of these massifs is that of the High Tatra (2663 meters), sculptured by Quaternary glaciers, with cirques occupied by small lakes overtowered by steep walls of dark red rock or wood-clad slopes of a deep green under a blue sky, and snow fields which vanish only late in the summer. One can well understand the brilliancy of colors displayed in the national paintings and embroideries and their perfect blending! No wonder that health resorts and tourist centers are being developed in these mountains which rival in their beauty the most renowned attractions of Switzerland.

The main river of this region is the Váh (Waag), a tributary of the Danube, which it joins in the great Slovakian plain on the southern border of the Carpathian Mountains. Where the Danube crosses the Carpathian arc the principal town of Slovakia, Bratislava (Pressburg), arose. With Komárno a little farther downstream it is the chief Czechoslovakian port on the Danube, and the contemplated construction of a waterway between the Labe (Elbe) and Danube would greatly increase its importance. The Slovakian plain is but a part of the huge Pannonian down-fault within the Carpathian arc. Economically it resembles the southern part of the Moravian corridor.

Northward along the rivers flowing down from the Carpathian Mountains the plain gradually peters out. On the Váh a narrow gap, where the hot springs of Trenčin have created a spa, leads from the plain to the first and most important of the intramontane basins, that of Žilina. This is a railway junction and a center of the main manufacturing industries characteristic of the Carpathians—wood working, pulp making, the working of wool, flax, pottery, glass, and iron, for which last-named industry the mines of the Slovakian Ore Mountains furnish the raw material. All the other materials are produced on the spot: coal has to be brought thither from Ostrava, but the white coal of the bordering mountains already furnishes a considerable part of the motive power.

Upstream of the Váh we pass through the basin of Turec to the great basin south of the High Tatra. By an imperceptible divide its western part, the basin of Liptov, where rise the headstreams of the Váh, is distinguished from the basin of Spiš where the Hernad, the chief tributary of the Tisa, and the Poprad, which crosses the Flysch mountains to join the Vistula, have their headwaters. Here likewise manufacturing is in progress together with farming and lumbering, and little ancient towns are to be found all along the former highroads, now deserted for the railroad. But it should be observed that these towns of Slovakia are in no way like American or western European towns. They are in fact more like large

FIG. 8

FIG. 9

FIG. 10

FIG. 8—A Slovakian village: the square before the church. Note the white or light tinting of the house walls and the characteristic overhanging roofs. (Photograph by Professor Vitásek.)

FIG. 9—Panorama of the High Tatra seen from the basin of Spiš. The contrast between the mountains and the flat-bottomed basin would be still sharper but for the waste cloaking the lower part of the fault scarp.

FIG. 10—A shepherd's hut, *salaš*, near the tree line in Carpathian Ruthenia. (Photograph by Professor Jiří Král.)

villages: only the central square has proper houses instead of huts, and these for the most part are but one-storied.

The valley of the Hron (Gran), the second large tributary of the Danube with a course parallel to that of the Váh, borders the Slovakian Ore Mountains to the north and separates them from the mountains of Štiavnica and Kremnica to the west. These volcanic mountains of Tertiary age give rise to rather broken and hummocky country with woods, pastures, small fields, orchards, and vine-clad southern slopes. A mountain railroad with numerous tunnels and lofty viaducts connects Štiavnica with Kremnica, lying picturesquely at the foot of the hill crowned by the station, the town reappearing at each curve of the train, winding up to cross the mountain barrier on its way to Turec. From ancient days gold and silver, together with copper, have been mined in this volcanic region, and the mint of Czechoslovakia was established at Kremnica.

The crystalline schists of the Ore Mountains of Slovakia contain iron, copper, and manganese; and in the small valleys in the heart of uninhabited, almost primeval, forests we come upon forges and rolling mills. Báňská Bystrica on the Hron may be said to be the economic center of this mining region, though situated on its northern border. In this town the mansions of the medieval mining masters with gates carrying armorial bearings give to the great central square its distinctive physiognomy.

East of the Tatra and the Ore Mountains the crystalline rocks disappear along the tectonic trough of the Hernad, where the Pannonian plain extends northward to the very edge of the Flysch zone. This corridor is the chief meridional highway of Slovakia; and larger towns, Košice (52,699 inhabitants) and Prešov (17,581), arose here, chiefly Jewish market centers. To the east the corridor of the Hernad is bordered by the Tertiary volcanic mountains of Prešov, in the andesites of which beautiful opals are mined. Here, too, mineral and hot springs are the last tokens of former volcanic activity.

In the Prešov district about the frontier between Slovakia and Carpathian Ruthenia three different regions may be distinguished. That of the Flysch zone is low in the west but rises towards the east in the Czornahora to over 2000 meters, the summits being sculptured by Quaternary glaciers. Whether of greater or lesser elevation these mountains are almost invariably covered by uninhabited woods. The poor soil and the severe climate—the region is unprotected to the north—allow only the cultivation of the more hardy crops, oats and potatoes, in the more sheltered valleys. Where the mountains rise above the upper tree line, at an elevation of about 1300 meters, isolated *salašes* are the temporary abodes of the seminomadic shepherds (Fig. 10).

A volcanic range, the Vihorlat Mountains, hugs the southern border of the Flysch zone in the west. Farther eastward the volcanic mountains trend to the southeast and, crossing the Tisa, continue as the Gutin Mountains of Rumania. Their vine-clad slopes separate the basin of the upper

Tisa, the Marmaroš, from the northern gulf of the Pannonian plain around Užhorod.

The Neogene sea entered the mountain-walled basin of the Marmaroš, and herein thick beds of rock salt were deposited. The salt resources of the Marmaroš seem to be inexhaustible, and they are the more precious as they are the only ones in Czechoslovakia. Chemical works are springing up in the vicinity of the mines; and, as the plain west of the Vihorlat Mountains is rich in lignites of excellent quality though still little worked, a center of chemical manufacturing will probably originate here in the far east of Czechoslovakia—a counterpart to that of Ústi-on-the-Labe (Aussig) in the west, where the northwest Bohemian lignite field reaches the trade route of the navigable Labe, providing cheap carriage for raw material often brought from a distance.

The valley of the upper Tisa lies in the axis of the basin. Though only some four kilometers broad, the valley is more than 70 kilometers in length; and, as it has fertile soil and a genial climate, we find here a strip of highly cultivated land. Its orchards, alternating with fields, offer a pleasing contrast to the Ruthenian steppes west of the Gutin Mountains. That part of the Pannonian plain is still sinking and at a quicker rate than the Tisa and its tributaries accumulate. Accordingly swamps, but recently drained, covered the entire region. It is a fertile but in no way a beautiful district—monotonous, level, yielding rich harvests, but unrelieved by tree or bush.

These are the varied features of Czechoslovakia. Regions of beauty and utility, great mountains and productive fields form the "vlast," as we call it, "the land that belongs to us."

AN ICE-ERODED FIORD

THE MODE OF ORIGIN OF LYNN CANAL, ALASKA*

By Lawrence Martin and Frank E. Williams

Lynn Canal-Chatham Strait is the longest and straightest and probably the most interesting, important, and picturesque of the many large fiords in southeastern Alaska. It extends in an almost direct line for 250 miles across the Coast Range of British Columbia and Alaska and the mountainous outlying islands. It is from one to five miles wide and has an extreme depth of 2900 feet. At the north it divides into Chilkat and Chilkoot Inlets. Within an area 350 miles long and having an average width of about 150 miles, extending from latitude 54° 40′ to 59° 30′ N. and from longitude 130° to 137° W., is a fiorded coast like that which continues southward with equal grandeur in British Columbia. It is one of the great fiord regions of the world, comparable in scale to the coasts of Norway, Greenland, New Zealand, and southwestern Chile.

The Lynn Canal-Chatham Strait fiord is in a mountain region where glacial erosion, stream erosion, change of level of the land, and faulting have all taken place. Its origin may, therefore, be thought to have involved: (1) ice erosion alone; (2) stream erosion chiefly, followed by sinking of the land; (3) stream erosion and glacial erosion, followed by submergence; (4) faulting as a major cause; (5) some combination of all four. It is the purpose of this paper to show that the fiord is due chiefly to glacial erosion and that stream erosion and faulting are of minor importance.

Many fiords of varying size join this straight waterway. Some of them are small tributary inlets, while others are wide passages nearly as deep as Lynn Canal-Chatham Strait. Among the former are Berners Bay, St. James Bay, Tenakee Inlet, Tebenkof Bay, and many smaller indentations. Of the larger class are Glacier Bay-Icy Strait, Stephens Passage, Peril Strait, and Frederick Sound-Taku Inlet. Most of these are submarine troughs which were probably original tributaries to a preglacial valley on the site of the present Lynn Canal-Chatham Strait fiord.

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* Various parts of this fiord have been discussed by Nordenskjöld, Davidson, Brooks, Gilbert, Spencer, the Wrights, Knopf, and others. Gilbert, especially, studied the effects of glaciation. The senior author of this paper has seen all of Lynn Canal, Chatham Strait, Frederick Sound, Stephens Passage, Icy Strait, Cross Sound, and Peril Strait, except a short stretch in Chatham Strait between Peril Strait and Frederick Sound. Most of these fiords he has traversed several times by daylight in connection with six trips to Alaska. He studied portions of Lynn Canal-Chatham Strait and its tributaries in detail, working on shore and from launches in 1905, 1911, and 1913. He visited Glacier Bay, Dundas Bay, Taylor Bay, and Excursion Inlet, north of Cross Sound-Icy Strait; localities at Flynn Cove south of Icy Strait on Chicagof Island; at Davidson Glacier, Skagway, and Tee Harbor on Lynn Canal; at Juneau and Treadwell gold mine on Gastineau Channel; near Taku and Norris Glaciers on Taku Inlet; and at Funter Bay and Killisnoo on Admiralty Island east of Chatham Strait. He sailed through these and other parts of this fiord system on steamships in 1904, 1909, and 1910, accompanied in the latter year by the junior author.

There are no tidal glaciers in the main fiord, but many small ice tongues lie on the steep slopes of Lynn Canal and its tributaries. East of Lynn Canal the large Mendenhall, Eagle, and Herbert Glaciers still terminate 100 to 400 feet above sea level. West of the fiord one moderate-sized glacier, the Davidson, ends almost at sea level. There are fifteen or twenty large ice tongues in the Glacier Bay tributary of Lynn Canal and four in Taku Inlet, most of those in the last two fiords entering tidewater. The evolution of drainage from preglacial through glacial to present conditions is shown in Figure 1.

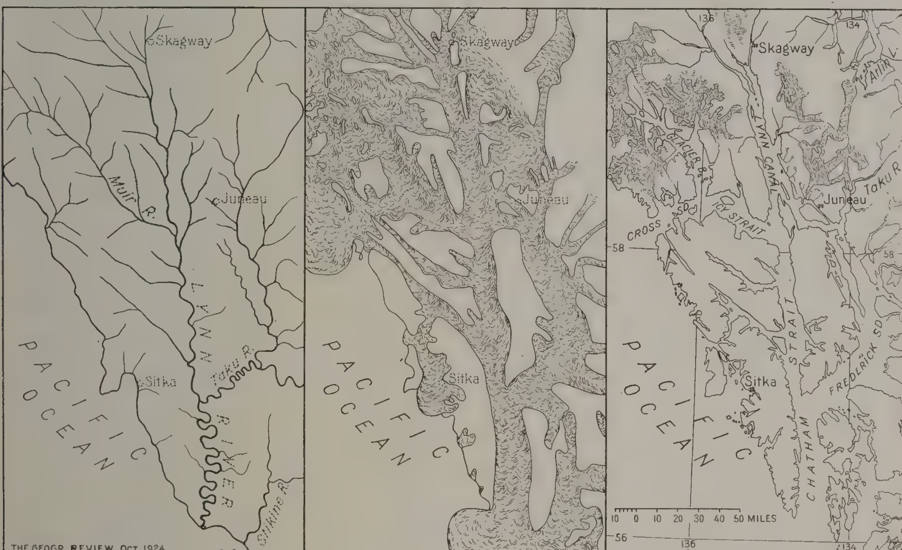


FIG. 1—Maps showing the evolution of the drainage of the Lynn Canal region: on the left, probable preglacial drainage; in the center, the more important glaciers at the flood stage; on the right, present fiords and glaciers.

Cross Section of the Fiord

The slopes above and below sea level are essentially the same. The fiord has steep walls (Figs. 5, 9) and, in most places, a wide, almost flat bottom. In northern Lynn Canal the fiord walls rise 4000 to 6000 feet above sea level and, as the water is 900 to 2400 feet deep, the total relief represented in the cross section exceeds a mile at many points. In Chatham Strait the fiord walls are generally lower, although just north of Frederick Sound the relief is 5180 feet—from Table Mountain, 2438 feet, to the bottom of Chatham Strait, 2742 feet. The greater width makes the fiord cross section seem flatter toward the south. Indeed, to the average traveler the most imposing fiord scenery in Lynn Canal-Chatham Strait is at the north in Taiya Inlet, where the fiord is both steep-sided and narrow. This applies especially to the view as one sees it from a ship (Fig. 10). The prospect from any point on the fiord walls is everywhere impressive, as in the photograph

of a broad part of Lynn Canal (Fig. 9). The cross section is less a U-shape than that of a wide, flat pan with flaring sides. The fiord walls are not precipitous, for an angle greater than 45° is uncommon, while the average is probably much less than 30°.

A comparison of the fiord cross section with that of an ordinary, un-

FIG. 2—Photograph of relief map of Lynn Canal and Glacier Bay-Icy Strait, the two northern tributaries of the Chatham Strait fiord, showing glaciers existing in 1894 whose expanded ancestors carved out Lynn Canal-Chatham Strait (W. F. King, Canadian Boundary Survey). The numbers have reference thus: 1, Mt. Fairweather; 2, Lituya Bay; 3, Mt. Crillon; 4, Cape Spencer; 5, Taylor Bay; 6, Dundas Bay; 7, Berg Bay; 8, Pt. Gustavus; 9, Pt. Couverden; 10, Taku Inlet; 11, Pt. Bridget; 12, Pt. St. Mary; 13, Berners Bay; 14, Pyramid Harbor; 15, Pyramid I.; 16, Skagway; 17, White Pass; 18, Chilkoot Pass.

glaciated river valley converted into an arm of the sea by the sinking of the land brings out the salient features of each.

It may be seen by a study of maps of the same scale that the trough of Chatham Strait, Alaska, is much wider than that of Delaware Bay in the eastern United States, but their chief difference is not in size but in the slopes of the submarine valley walls (Fig. 13). The cross section of the Hudson north of New York, where it was modified by glaciation, is also

drawn for comparison. The slopes of the channel walls of Delaware Bay and Hudson River are so gentle that they cannot be shown without exaggerating the vertical scale. The submarine walls of Chatham Strait can easily be drawn to natural scale and show a steeper slope than those of Delaware Bay and Hudson River, although the vertical distances in the cross section of the latter have been multiplied by four. The wide, flat-bottomed, steep-sided troughs of the fiords, as contrasted with the nar-

FIG. 3

FIG. 4

FIG. 3—Juneau, the capital of Alaska. Juneau is on Gastineau Channel, one of the tributaries of Stephens Passage, a fiord confluent with Lynn Canal.

FIG. 4—The glacially oversteepened fiord wall of Gastineau Channel at Juneau.

rower river valleys with gentle slopes, show clearly the effects of profound glacial scouring and marginal trimming.

LONGITUDINAL SECTION OF THE FIORD

Above sea level the longitudinal section of the fiord is simple. Between valleys the spurs are sharply truncated. Uninterrupted views cover exceedingly long distances, as in most glaciated valleys (Fig. 18). The depth of the fiord is 1400 feet near the southern end of Taiya Inlet, 400 feet at the junction of Taiya and Chilkoot Inlets, 2900 feet off the northeast coast of

Baranof Island in Chatham Strait, 2100 feet east of Cape Ommaney, and 1000 to 1500 feet at the mouth of Chatham Strait in the Pacific Ocean. These depths of water show that there is not a gradual slope from the head of the fiord to the mouth but that there are alternations of deep basins and relatively shallow stretches. Figures 15 and 16, which represent the bottom of the main channel of the whole fiord, reveal numerous irregularities in the longitudinal profile. This shows remarkable contrast with the profile of a river; for irregularities of a few feet in the bottoms of stream courses are notuncommon, but differences of several hundred or a thousand feet or more are never found.

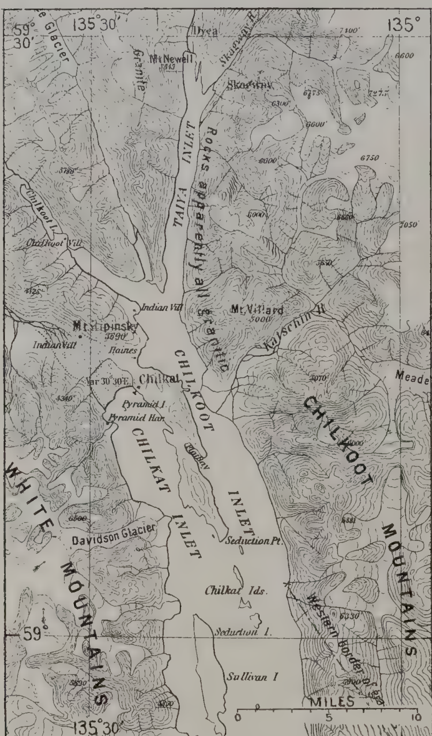


Fig. 5—The northern portion of the Lynn Canal fiord, showing the topography above sea level. Contour interval 500 feet. Reduced from Sheet III, Map of a portion of the Yukon District, Northwest Territory with the adjacent Northern Part of British Columbia, by G. M. Dawson, edit. of 1898.

Tributaries of the Main Fiord

Many tributaries having the same characteristics as Lynn Canal-Chatham Strait have been studied in connection with the problem of the main fiord. The largest tributary fiords are twelve in number. They may be identified upon various maps illustrating this article. Almost all of them show a depth of at least several hundred feet, and some are from 1500 to 1700 feet deep, Frederick Sound being the deepest. They are all remarkable for their straight and steep sides and for their flat bottoms. They range in size from Gastineau Channel, which is 17 miles long and 1½ miles wide, to Stephens Passage, which is 120 miles long and from 4 to 15 miles wide.

Hanging Valleys

Near Lynn Canal a great number of valley troughs terminate at different heights as hanging valleys. In many places there has been scarcely any stream erosion since the disappearance of the ice, and accordingly waterfalls are numerous. Some of the best and most picturesque of these hanging valleys are in Taiya Inlet near Skagway (Fig. 21) and in Glacier Bay (Fig. 20).

Soundings show many submarine hanging valleys also. The bottom of Skagway Harbor hangs between 200 and 300 feet above that of the main

fiord which terminates at Dyea. The bottom of St. James Bay hangs 800 feet above that of Lynn Canal. Irregularities in the bottom of the fiord render it difficult to determine the exact amount of discordance of Icy Strait, but it is clearly between 600 and 800 feet. The bottom of Frederick Sound hangs 1300 feet above that of Chatham Strait (Fig. 22). Freshwater Bay, Tenakee Inlet, and Hooniah Sound are discordant by amounts of 900 to 1100 feet. The floors of smaller tributary fiords hang at even greater elevations above the main fiord floor—the bottom of Hood Bay is 1400 feet above that of Chatham Strait, and the bottom of Funter Bay is 1700 feet above that of Lynn Canal. There are also secondary submarine hanging valleys, as in certain tributaries of Frederick Sound-Stephens Passage. In speaking of what he regards as the small amount of work accomplished by glacial erosion Knopf says: "It is therefore a problem of some interest why the troughs of the transverse tributaries, such as those of Berners, Eagle, and Mendenhall Rivers, are not hung up high above the bottom of Lynn Canal."[1] He seems to have overlooked the soundings, which show that Berners Bay does hang 300 feet above the bottom of Lynn Canal. Moreover, it will be necessary to know to what depth the Eagle and Mendenhall Rivers have deposited material in the fiord at their mouths before it can be stated that they meet the main channel with accordant junctions and are not hanging valleys in relation to the bottom of the fiord.

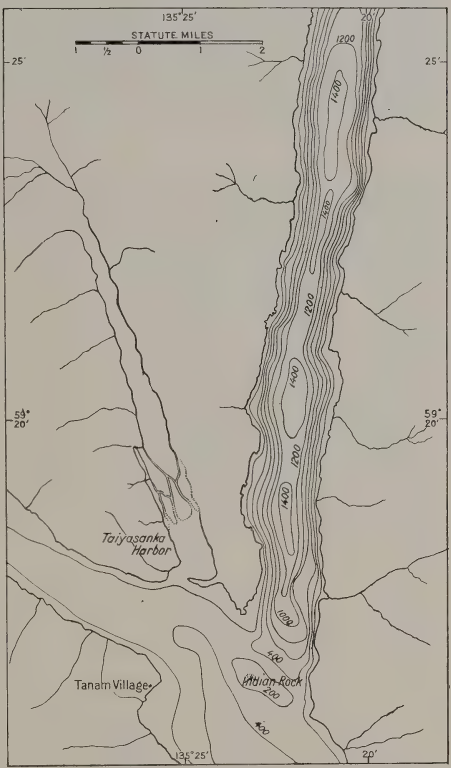


FIG. 6—Map of part of Taiya Inlet at the head of Lynn Canal, showing its outline and form to be entirely different from that of a drowned river valley like Chesapeake Bay (compare Fig. 13). Based upon Chart 8303, U. S. Coast and Geodetic Survey.

The Origin of Islands and Reefs

There are a few islands in the northern half of Lynn Canal-Chatham Strait. Shelter Island, one of the largest, is about ten miles long. Several of the islands are more than 500 feet high, but none in this fiord reach a height of 1000 feet; while the fiord walls are four to six times as high. Some

[1] Adolph Knopf: The Eagle River Region, Southeastern Alaska, *U. S. Geol. Survey, Bull. 502*, 1912, pp. 12–13.

islands rise only a score of feet above sea level, and some reefs are awash; but the latter are rare. The wire-drag surveys show that the fiords of southeastern Alaska contain many submarine pinnacles that were not revealed by sounding. The reefs at the north end of Sentinel Island west of Eagle Glacier, where the steamship *Princess May* was wrecked in 1910

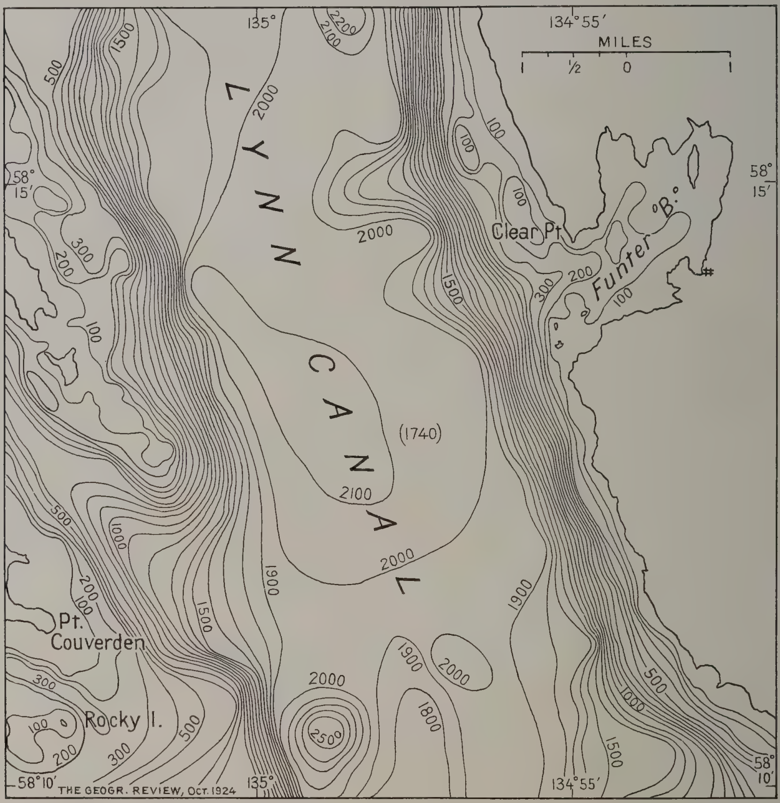


FIG. 7—Map of Lynn Canal near its junction with Glacier Bay-Icy Strait, showing the steep submarine wall of the fiord and its flat floor. Contour interval 100 feet. Based upon Chart 8302, U. S. Coast and Geodetic Survey.

and the *Princess Sophia* at a subsequent date, constitute a menace to navigation attributable to the differential glacial sculpture that has left these rare reefs and islands of resistant rock in the broader stretches of fiord. The southern half of the fiord is devoid of islands, with the exception of small ones near the shore. The soundings show few submarine knobs. Islands are absent where the fiord is narrow and deep and are more numerous in the broad, shallow stretches. This suggests that where the fiord is narrow the ice may have occupied one preglacial valley and that in some of the places where it is broad it filled parallel or converging valleys, overriding the minor divides. The ice wore down the divides as well as the valley bottom; but some of the eminences remained high enough to appear

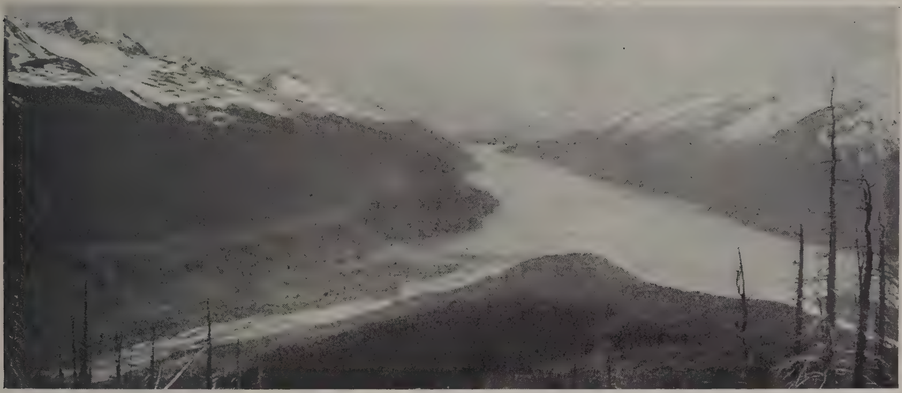


FIG. 8

FIG. 9

FIG. 10

FIG. 8—Taiya Inlet at Skagway, showing the head of the Lynn Canal fiord. (Photograph by L. M. Prindle.)
FIG. 9—Lynn Canal at the junction of Chilkat and Chilkoot Inlets. Davidson Glacier on the left. (Photograph by N. J. Ogilvie.)
FIG. 10—The steep eastern wall of Lynn Canal, showing small glaciers along the fiord.

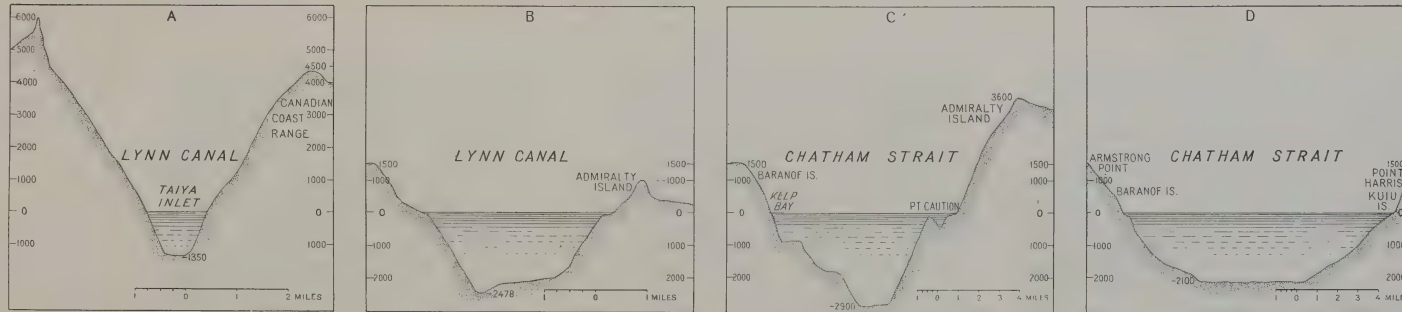


FIG. 11

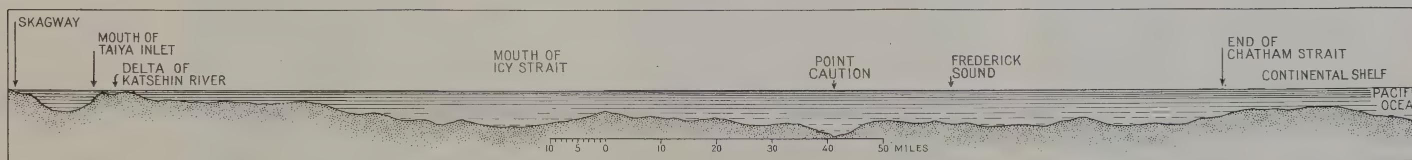


FIG. 12

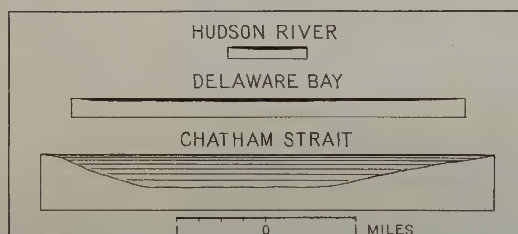
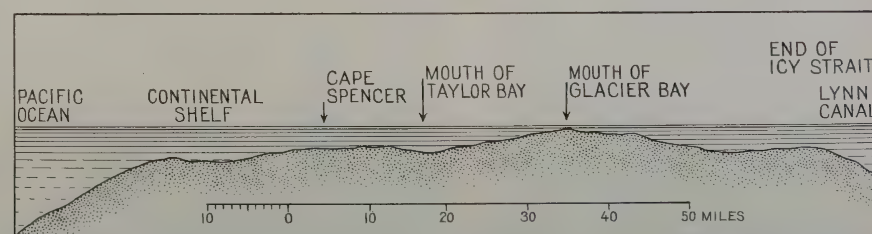


FIG. 13



THE GEOGR. REVIEW, OCT. 1924

FIG. 14

FIG. 11—Cross sections of Lynn Canal-Chatham Strait. A, just south of Skagway; B, 80 miles farther south near the mouth of Icy Strait; C, near Peril Strait at the deepest point in the fiord; D, near the mouth of the fiord, 10 miles from the Pacific Ocean.

FIG. 12—Longitudinal section of Lynn Canal-Chatham Strait, showing its basined character. Vertical scale about 16 times horizontal scale.

FIG. 13—Cross sections of Hudson River (above), Delaware Bay (middle), and Chatham Strait (below). The vertical scale of the two former is exaggerated four times; that of Chatham Strait is drawn to true scale.

FIG. 14—Profile through Icy Strait and Cross Sound, showing the submarine divide at the mouth of Glacier Bay. It is suggested that the connecting of these two preglacial river valleys is due to glacial erosion without sinking of the land. Vertical scale about 16 times horizontal scale.

above sea level at the time when the ice tongues melted away and glacial erosion ceased.

The slopes of the islands are about the same as those of the neighboring mainland—some quite steep, others rather gentle. The longer axes of the principal islands have, in general, the same trend as the coast of the mainland, which is more nearly northwest than the trend of the fiord and agrees with the strike of the rocks. Practically all the islands are in line with adjacent peninsulas, of which they are clearly cut-off portions. Their position and trend suggest a relationship to resistant rock and preglacial drainage. The presence of islands in a glaciated fiord is not remarkable, even if the rock were of the same resistance. Islands seem to have the same relation to ice currents that rock reefs bear to river currents.

The Mouth of the Fiord

The scattered Coast and Geodetic Survey soundings off the mouth of Chatham Strait show a wide submarine channel with relatively steep sides, extending from the fiord across the continental shelf. The fiord mouth, then, is not at the edge of the land but about 30 miles out at sea. This channel is 1000 to 1200 feet deep and between 15 and 20 miles wide. There are also excellent data to show the continuation of Cross Sound across the continental shelf. There is a definite, wide, steep-sided trough, about ten miles wide at Cape Spencer and nearly 30 miles wide and 1400 feet deep at the edge of the continental slope (Fig. 16). Such submarine channels as the two just mentioned might have been the result of: (1) ice tongues extending across the continental shelf and eroding below sea level, because the water was not deep enough for them to be afloat; (2) submerged stream valleys; (3) stream valleys that have been deepened and widened by glaciers and then submerged; (4) rift valleys made by faulting. The supposition that faulting is responsible for the channels requires a conception of a complicated fault system and a repetition of down-faulted valleys. At present no tidal glaciers in Alaska extend far beyond their confining walls into large bodies of water, but the ice tongues that filled these valleys at the maximum stage of glaciation were much larger and may have extended a short distance into the sea. The submarine channels that are definitely known to be due to stream erosion are either narrow gorges or very wide troughs with gentle slopes. There are submarine valleys off the mouths of many rivers along the eastern coast of North America. The submarine gorges of the Hudson and Delaware Rivers are, perhaps, the best known. The former is deeper than the Cross Sound and Chatham Strait channels but is much narrower. It averages less than two miles in width and nowhere exceeds four miles.[2]

The wide, steep-sided, submarine channels of southeastern Alaska, their position off fiords known to be glaciated, their width as compared with the

[2] J. W. Spencer: The Submarine Great Canyon of the Hudson River, *Amer. Journ. of Sci.*, Ser. 4, Vol. 19, 1905, pp. 1–15.

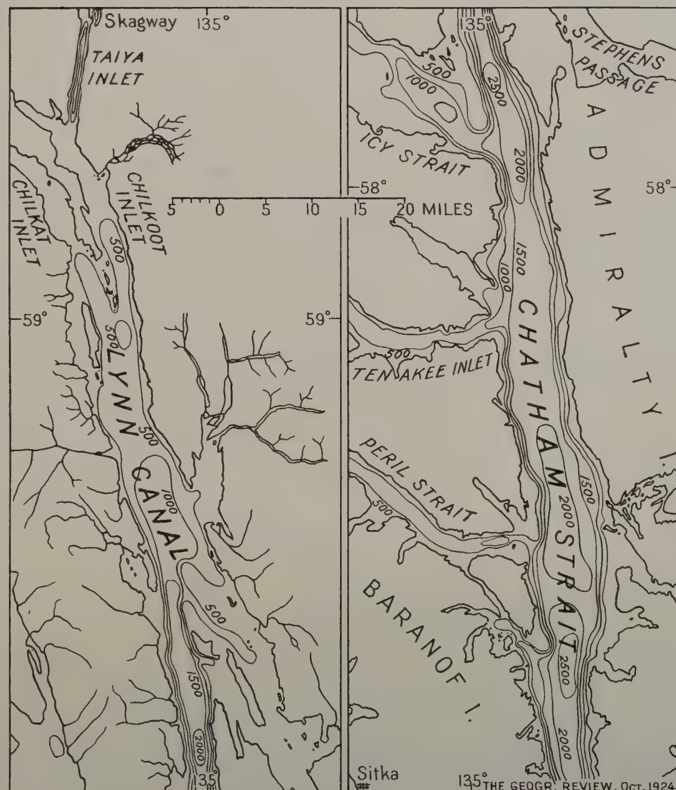


FIG. 15

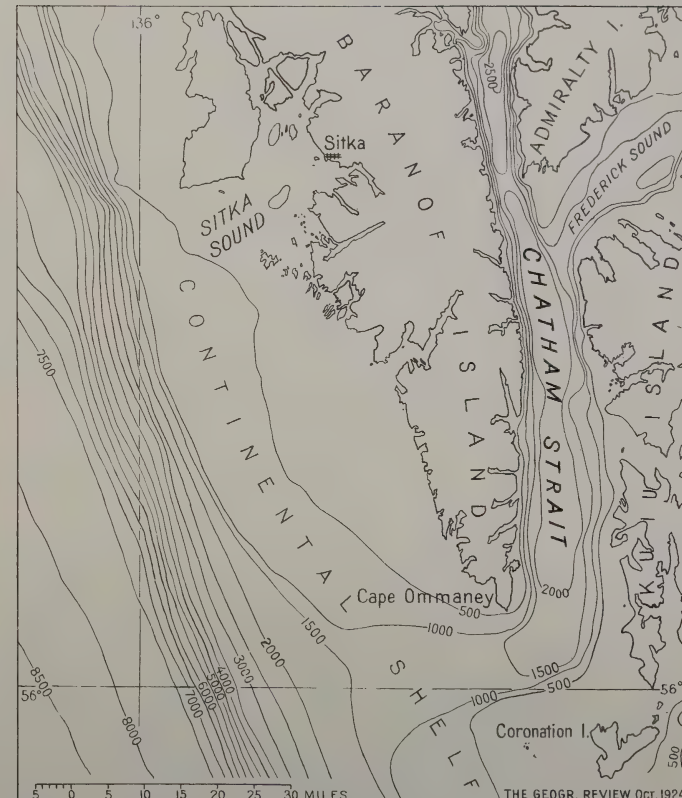


FIG. 16

FIGS. 15 and 16—Maps showing the submarine basins and swells in Lynn Canal-Chatham Strait. Figure 16 shows the fiord extending across the continental shelf into the Pacific Ocean. Contours in feet. Based upon Chart 8002, U. S. Coast and Geodetic Survey.

fiords, their resemblance in general shape to known glaciated valleys—all suggest that they are channels whose form was determined almost entirely by glaciers. The Lynn Canal-Chatham Strait fiord seems to continue across the continental shelf in practically the same manner as a submerged, stream-eroded valley but to differ in form.

Origin of Fiords by Glacial Erosion

Brooks stated in 1902 that, in southeastern Alaska, he was "strongly impressed with the fact that ice action has played a very important part in producing the present topographic forms."[3] Gilbert did more than any one else to establish the fact that glaciers can and do erode below sea level,[4] as indeed Muir concluded from observations more than forty years ago.[5] Gannett concluded that "from Lynn Canal, a fiord ninety miles in length, there have been carried off and dumped into the Pacific more than 200 cubic miles of rock, and from all the fiords of southeastern Alaska the amount removed may be safely estimated at thousands of cubic miles."[6] Tarr made more specific than anyone had previously done the results of faulting, rejuvenation, sinking of the land, etc., showing that the features to be seen in western British Columbia and southeastern Alaska could be produced by none of these exclusively but that glacial erosion has been the main factor.[7]

More recently, however, the adequacy of ice sculpture, wholly or in part, has been called into question and by men who have studied the fiords of southeastern Alaska from the coast as well as from passing ships. F. E. and C. W. Wright seem to the present authors to give a disproportionate emphasis to faulting and indeed to infer a major fault along the axis of Lynn Canal-Chatham Strait without convincing statements of evidence.[8] Still more recently Knopf has described a part of Lynn Canal with a hesitancy about the effectiveness of the glacial erosion which seems to us unwarranted.[9] Grant and Higgins,[10] working in Prince William Sound several hundred miles to the northwest and recognizing glacial erosion in general, have seemed to find it necessary in one case to infer postglacial sinking of

[3] A. H. Brooks: Preliminary Report on the Ketchikan Mining District, Alaska, with an Introductory Sketch of the Geology of Southeastern Alaska, *U. S. Geol. Survey Professional Paper 1*, 1902, p. 35.

[4] G. K. Gilbert: Alaska: Glaciers and Glaciation (Harriman Alaska Expedition, Vol. 3), New York, 1904, pp. 156, 159, and 217.

[5] John Muir: The Mountains of California, New York, 1894, pp. 24–26.

Idem: Notes on the Pacific Coast Glaciers, in "Alaska: Narrative, Glaciers, Natives," by John Burroughs, John Muir, and G. B. Grinnell (Harriman Alaska Expedition, Vol. 1), New York, 1902, pp. 119–135; reference on pp. 128–129.

Idem: Travels in Alaska, Boston and New York, 1915, p. 17.

[6] Henry Gannett: General Geography in "Alaska: History, Geography, Resources," by W. H. Dall and others (Harriman Alaska Expedition, Vol. 2), New York, 1902, pp. 257–277; reference on p. 259.

[7] R. S. Tarr: Glacial Erosion in Alaska, *Popular Sci. Monthly*, Vol. 70, 1907, pp. 99–119.

[8] F E. and C. W. Wright: The Ketchikan and Wrangell Mining Districts, Alaska, *U. S. Geol. Survey Bull. 347*, 1908, p. 22.

[9] Knopf, *op. cit.*, p. 13.

[10] U. S. Grant and D. F. Higgins: Reconnaissance of the Geology and Mineral Resources of Prince William Sound, Alaska, *U. S. Geol. Survey Bull. 443*, 1910, p. 16.

Idem: Coastal Glaciers of Prince William Sound and Kenai Peninsula, Alaska, *U. S. Geol. Survey Bull. 526*, 1913, p. 72.

the land and in another to infer graben faulting in order to explain certain broad channels, submerged hanging valleys, and straight stretches of fiord which appear to a larger number of other competent observers to require no such complications.[11] It has even been suggested that the hanging valleys in the fiords between Prince Rupert and Vancouver, B. C., are not due to glacial erosion.[12] Lastly a book on fiords has been published by Gregory who believes all fiords to be due to earth movements (faulting).[13]

The Alaskan section of the book by the last-named author contains many misstatements and erroneous conclusions. Figure 54 (p. 293), for example, represents the coast of the Alaska Peninsula west of Afognak and Kodiak Islands as a "non-glaciated coast with fiords." As a matter of fact, this coast has many fair-sized ice tongues, as the senior author of this paper observed when he visited it in 1904. During the maximum of the Glacial Period it had much larger ice tongues, glaciers capable of accounting for all the fiords there present. The same map erroneously shows as "glaciated coasts without fiords" the region between Prince William Sound and Cross Sound, alluding to it in several places in the text as "a long even coast broken only by Yakutat Bay." Here, however, most American physiographers believe fiord making byglacial erosion to be still in progress. Here, moreover, are many fiords, for we must include under the name fiord not only arms of the sea but (*a*) troughs which the sea will fill when present glaciers retreat and (*b*) former arms of the sea partly obscured by glacial and glacio-fluviatile deposits. Gregory completely overlooks: (1) Lituya Bay, one of the finest fiords in the world; (2) the fiords northwest of it near Cape Fairweather; (3) the fiords southeast of Lituya Bay at La Pérouse Glacier, in both the latter cases still brimming with glacier ice; (4) Alsek Canyon, where the mouth of a great fiord is filled with living glaciers and their outwash deposits; (5) troughs at Malaspina Glacier, whose piedmont ice mass and tributary glaciers possibly conceal two fiords equal to Yakutat Bay in extent, which may be revealed at the next glacier minimum, to say nothing of smaller fiords; (6) troughs at Bering Glacier where a similar condition may exist; (7) Copper River Canyon, where a great fiord is partly filled with deposits of glacial outwash. The present occupation of these fiords and canyons by active glaciers and their deposits is an argument for rather than against the glacial molding and excavation of the valleys along this coast.

R. S. Tarr was entirely convinced that glacial erosion was far more important than faulting in making the topographic forms at Yakutat Bay and Russell Fiord. Gregory has no right to say that "Tarr and Martin's memoir shows that the formation of fiord-valleys by trough-faulting is still in progress in Alaska."[14] We seriously question the propriety of

[11] F. C. Schrader and A. C. Spencer; Copper River District, Alaska, *56th Congr., 2nd Sess., House of Repr. Doc. 546*, Washington, 1901, p. 82.

[12] *Compte Rendu Congrès Géol. Internatl.* XII, Ottawa, 1914, p. 1027.

[13] J. W. Gregory: The Nature and Origin of Fiords, London, 1913.

[14] Gregory, *op. cit.*, p. 309.

FIG. 17

FIG. 18

FIG. 19

FIG. 17—A low glacially eroded island in Lynn Canal.

FIG. 18—Looking down Lynn Canal: an extended view made possible by the removal of overlapping spurs through glacial erosion.

FIG. 19—A hanging valley with waterfall in the northern part of Lynn Canal.

Gregory's statement that "in a later memoir Tarr attached less importance to glacial action." In the memoir referred to, Tarr affirmed his own previous statements about glacial erosion most strongly.[15]

Gregory's quotation from John Burroughs (p. 321) appears unfortunate to us, for he overlooks the fact that Burroughs was describing scenery rather than structure when he said: "The edge of this part of the continent for a thousand miles has been broken into fragments, small and great, as by the stroke of some earth-cracking hammer." He certainly did not mean this to be interpreted literally as evidence of his belief in the making of the fiords by some tectonic force, as Gregory implies, any more than Muir meant that the fiords had been made with an embroidery needle when he said: "It is a web of land and water thirty or forty miles wide, and about a thousand miles long, outspread like embroidery along the margin of the continent."[16]

Gregory has printed authority in Spencer for his view that the hanging valleys along Copper River are due to faulting, and in Spurr for errors regarding the Alaska Peninsula. It is difficult to know why Gregory (p. 305) located the Nizina District in Prince William Sound, when it is nearly 150 miles inland beyond a great mountain range. There seems no warrant for the view that the evidence of slightly larger ice masses in Seward Peninsula (pp. 294–297 and 317) makes the fiordless American coast of Bering Sea a "glaciated coast without fiords." The authors cannot follow the reasoning that concludes (p. 318) that absence of fiords at right angles to the coast ("radial") in southeastern Alaska and British Columbia proves that "the development of the fiords appears quite independent of the glaciation of the country," or that the general plan and detailed topography "are alike inexplicable on the view that their plan was due to river or glacial erosion." We deny Gregory's statement (p. 319) that "in Alaska lakes are abundant in the non-glaciated areas as well as in the glaciated." We cannot agree with the generalization (p. 317) that "the distribution of fiords in Alaska does not coincide with the distribution of glacial activity." We regret Gregory's dictum (p. 306) that if there were fiords along the coast between Prince William Sound and Cross Sound "their ends should already have been unmasked," for we know of many troughs there that we should call fiords, to say nothing of the well-known fiord at Lituya Bay already alluded to. Because of such errors, upon which Gregory has based important conclusions, and because of many frank differences of interpretation, not enlarged upon here, we cannot accept Gregory's conclusion (p. 324) that the Alaskan fiords "appear to be of tectonic rather than of glacial origin."

The present paper is, therefore, written in support of the original contention of Muir, Brooks, Gilbert, Gannett, Tarr, and others. It is based

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[15] R. S. Tarr: The Yakutat Bay Region, Alaska, Physiography and Glacial Geology, *U. S. Geol. Survey Professional Paper 64*, 1909, pp. 116–119.

[16] John Muir: Alaska, *Amer. Geologist*, Vol. 11, 1893, pp. 287–299; reference on p. 287.

FIG. 20

FIG. 21

FIGS. 20 and 21—Hanging valleys in the Lynn Canal-Chatham Strait system. Figure 20 is in the northern part of Glacier Bay; Figure 21 near Skagway. Such forms are evidence for the conclusion that glacial erosion rather than faulting or sinking of the land has produced the present fiord.

upon field work on shore in Lynn Canal-Chatham Strait as in the case of the work of the Wrights and Knopf, in Prince William Sound, as in the

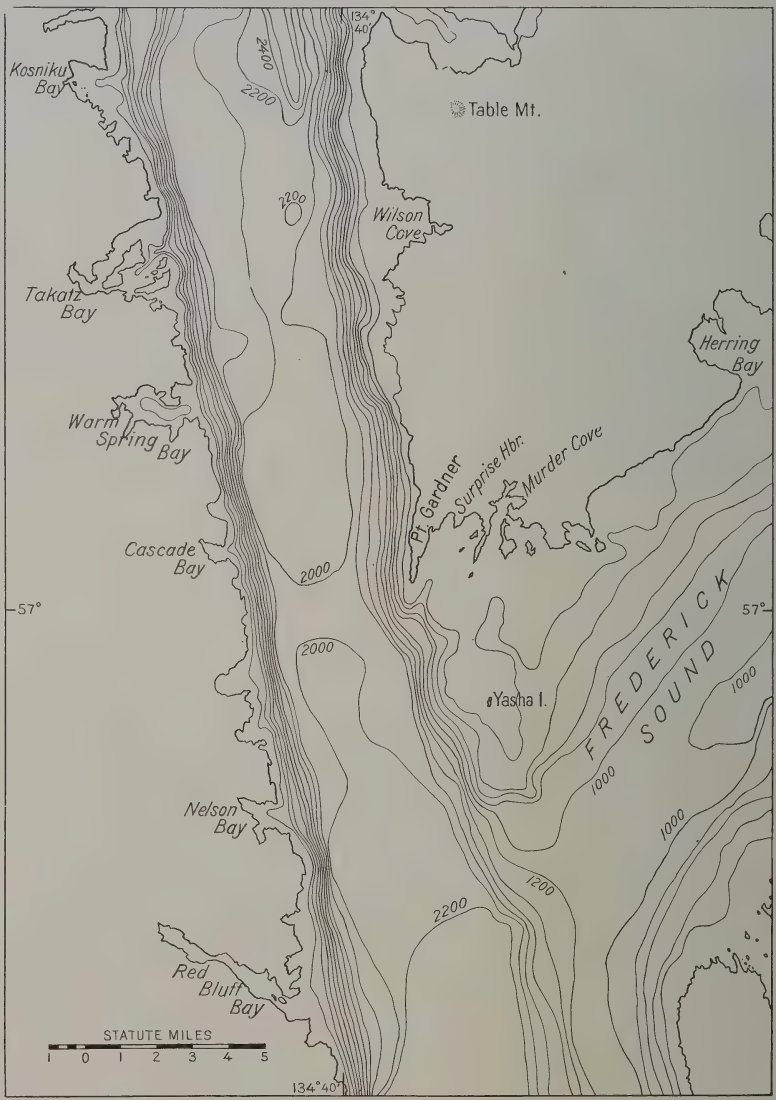

FIG. 22—Map showing a submarine hanging valley at the junction of Frederick Sound with Chatham Strait. The valley hangs 1200 feet. Note also the submarine valley of Warm Spring Bay hanging 1700 feet. Based upon Chart 8250, U. S. Coast and Geodetic Survey.

case of Grant and Higgins, and in Glacier Bay, Lynn Canal, and Yakutat Bay, as in the case of Gilbert, Gannett, Muir, Tarr, and others. It is based also upon a more detailed study than has been made before of the portions of Lynn Canal-Chatham Strait below sea level. The maps and cross sec-

tions here presented seem to us to furnish clear evidence that the form of Lynn Canal-Chatham Strait is due to glacial erosion. The junior author has drawn submarine contours on all available charts of the fiords of southeastern Alaska, upon the basis of the soundings published by the U. S. Coast and Geodetic Survey. This contouring has been done upon maps on scales of 1:80,000 in some cases and 1:200,000 in others. These submarine contours we have compared with the contours above sea level on all the existing maps of the International Boundary Survey and the U. S. Geological Survey for this region, so that the maps and the cross sections here presented constitute only a small portion of the material studied by us.[17] Our several seasons of observations in the field lead us to the same conclusion suggested by the map study, namely that faulting, stream erosion, and sinking of the land have played a subordinate rôle in the production of such an arm of the sea as Lynn Canal-Chatham Strait, where we believe that the major forms, below as well as above sea level, are due to glacial erosion.

The Direction of Ice Movement

The Lynn Canal-Chatham Strait fiord, whose main channel now contains no tidewater glaciers, was brimful of ice at the maximum of glaciation in Alaska. The ice tongues of Glacier Bay, Taku Inlet, and other tributary fiords are shrunken representatives of the Lynn Canal ice stream. It was

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[17] U. S. Coast and Geodetic Survey Charts 8300 and 8250 show the whole length of Lynn Canal-Chatham Strait on the scale of 1 : 200,000; for its eastern branches and other fiords southward to Dixon Entrance on the same scale see Charts 8200 and 8102; for more detailed charts of southern Lynn Canal and its western branch, Icy Strait-Cross Sound, see Charts 8303, 8302, and 8304 on the scale of 1 : 80,000; for the coast of the Pacific Ocean from Chatham Strait to Dixon Entrance see Chart 8152 on the scale of 1 : 229,000; for Glacier Bay, the northern extension of Icy Strait, see Chart 8306 on the scale of 1 : 160,000; for the mouths of the Chatham Strait, Cross Sound, and Dixon Entrance fiords on the continental shelf see Chart 8002; for some of the smaller submarine hanging valleys see harbor charts 8242 and 8246. Chart 8002—Dixon Entrance to St. Elias—shows the whole fiord system from southeastern Alaska to the Copper River. Chart 3089—Northwest Coast of America and Inland Passages—shows the fiords from Mt. St. Elias through Lynn Canal, southeastern Alaska, and British Columbia to Puget Sound, Washington, on the scale 1 : 1,200,000.

There are other government maps as follows: *U. S. Geological Survey:* "Juneau Special Map," scale 1 : 62,500, contour interval 100 feet, 1904; "Eagle River Region," scale 1 : 62,500, contour interval 50 feet, 1912; "Juneau Gold Belt," scale 1 : 250,000, contour interval 250 feet, 1905; "Berners Bay Special Map," scale 1 : 62,500, contour interval 50 feet, 1908; "Juneau and Vicinity," scale 1 : 24,000, contour interval 50 feet, 1918; "Copper Mountain and Vicinity," scale 1 : 62,500, contour interval 100 feet, 1908; "Kasaan Peninsula," scale 1 : 62,500, contour interval 50 feet, 1915; *Alaskan Boundary Tribunal and International Boundary Commission:* "Atlas of Award, 25 sectional maps and index map showing the line fixed by the Tribunal," sheets 10, 11, 12, 13, 14, 15, 16, 16a, 17, 18, 19, scale 1 : 160,000, contour interval 50 feet, published as *Senate Doc. No. 162, 58th Congr., 2nd Sess.*, Washington, 1904; "International Boundary between the United States and Canada from Cape Muzon to Mt. St. Elias," sheets 6, 7, 8, 9, 10, scale 1 : 250,000, contour interval 250 feet, 1922–1924, eventually to be published in an atlas of 13 sheets; *Alaska Road Commission:* "Map of Alaska, prepared by the American Geographical Society for the Alaska Road Commission, and published jointly, 1923," scale 1 : 1,250,000, contour interval 1000 feet; *U. S. Forest Service:* Tongass, Sheet 1, scale approximately 1 : 500,000, contour interval 1000 feet; for forest and water-power maps showing glaciated details of parts of the fiord walls and tributary land valleys with contours see the following: Admiralty Island, scale 1 : 63,360; Craters, Long, and Tease Lakes, scale 1 inch to 2000 feet; Keku Strait, scale 2 inches to 1 mile; East Coast Baranof Island, scale 2 inches to 1 mile; Suloia Lake, scale 1 inch to 1500 feet; Port Snettisham, scale 2 inches to 1 mile; Windham Bay, scale 2 inches to 1 mile; Silver Bay, scale 1 inch to 1500 feet. (Certain of these maps are available only as black and white proof sheets.)

A geological map of the whole inner fiord system of the Canadian Coast Range from Skagway to Dixon Entrance, on the scale of 1:250,000, may be made by putting together Plate 37 in Spencer's Bulletin 287 and Plates 2 and 3 in the Wright's Bulletin 347.

a valley glacier 250 to 300 miles long and 8 to 25 miles wide throughout most of its extent. At the flood stage of glaciation it must have been 3500 to 6000 feet in thickness, as is shown by the height at which till, striae, and erratics are found on the fiord walls, combined with the depth of water in the fiord. The tributary fiords were completely filled with flowing ice.

The direction of ice movement coincided generally with the trend of the present fiords, so far as striae have been observed. The distribution of erratics from the igneous mass of the Coast Range batholite supports this conclusion of southward and southwestward-moving ice tongues. This suggests that the ice was guided initially by preglacial valleys. The even sky line and the complex rock structures on the fiord walls and in the islands suggest that the preglacial drainage may have been inherited from a previous cycle when the mountains were reduced to a peneplain. The trend of Lynn Canal-Chatham Strait is diagonal to the strike of the sedimentary rocks. This may be caused by faulting, as discussed later, or it may mean that the fiord is the glacially-enlarged valley of a rejuvenated preglacial stream that acquired this course as a result of the uplift and tilting of an ancient peneplain. The minor topographic features, on the other hand, are directly related to the rock formations. Weak rock underlies many of the bays and tributary fiords. Resistant rock forms the peninsulas and islands.

The Rôle of Faulting

Faulting may very well have played a part in the formation of the fiords. If it did, the authors' view is that it was a minor part. The most striking suggestion of faulting is the length and straightness of Lynn Canal-Chatham Strait. It would be unusual if a river had acquired so direct a course for 250 miles as a result of mere tilting of a peneplain. The straight fiord is not due to any one stratum of weak rock, for it cuts at an angle of about 30° across the strike of the sedimentary and metamorphic rocks and the igneous masses which intrude them. Faulting is a natural explanation of the straightness of Lynn Canal-Chatham Strait. Our view, however, is that, if there is a fault line or shatter belt here, it merely determined the direction of the fiord. Its form alone—profile and sections—shows clearly that it is not a rift valley made by faulting. Faulting, as it seems to us, may have merely provided a zone of shattered and weak rock which guided the preglacial river and the ice stream of the Glacial Period. The absence of rift faulting is best proved by the absence of faults in the tributary fiords, where the pattern and cross section are identical. Nordenskjöld long ago suggested that the joint systems in Lynn Canal agree in direction with the trend of the fiord, though he did not imply that the fiord was not of glacial origin.

The Wrights and other workers in the area may have had this conception of the rôle of faulting, that the topographic form was not made by faulting, but that faulting merely provided a long, narrow strip of weak rock. The

absence of specific statements to that effect appears to have misled students, especially Gregory, who have never visited the region.

Absence of Evidence of Drowning of Valleys

There was a time when the very presence of fiords was taken as indubitable proof of sinking. This was because the conception of glacial erosion, below sea level as well as above sea level, had not yet been established. The fiords of southeastern Alaska present no conclusive evidence of submergence of the land. The plan and the profiles of the present fiords are distinctly different from what would be made by the drowning of normal (non-glaciated) stream valleys. They are typical of glacially-overdeepened and widened valleys or of submerged glaciated valleys; but sinking of the land is not a necessary factor in their formation. If it were argued that the Lynn Canal-Chatham Strait fiord involved sinking of the land without submarine glacial erosion, then it would be necessary to assume that the land had been submerged after having been nearly 3000 feet higher, for Chatham Strait is at least 2900 feet deep. Differential warping of 3000 feet seems improbable in view of the lack of warping of the upland surface. Our view is that there is no evidence of and no necessity whatever for invoking submergence. The pattern and form of the fiords, save for straightness alone, are those of glacial erosion. As the ice tongues melted back, the waters of the sea, according to our view, came in and occupied the fiords without sinking of the land. This is just what happened in Glacier Bay between 1794 and 1924, when a fiord more than 60 miles long was revealed by the recession of Grand Pacific Glacier, Muir Glacier, and adjacent ice tongues. Muir stated this very well in 1894, referring to all the fiords of southeastern Alaska: "The intricate labyrinth of canals, channels, straits, passages, sounds, narrows, etc., between the islands, and extending into the mainland, of course manifest in their forms and trends and general characteristics the same subordination to the grinding action of universal glaciation as to their origin, and differ from the islands and banks of the fiords only in being portions of the pre-glacial margin of the continent more deeply eroded, and therefore covered by the ocean waters which flowed into them as the ice was melted out of them."[18] Gilbert, however, concluded on other grounds that the preglacial stream valley in Lynn Canal may have been slightly below present sea level, being related to a lower base level. He conceived the glacial degradation as possibly averaging more than 1000 feet but concluded that "the existence of a fiord . . . is not demonstrative of a relatively low base-level at the time of its excavation."[19]

Uplift is certainly the latest known movement. This is established by the presence of shells of marine animals of Pleistocene age in deposits (1) on Pyramid Island, Chilkat Inlet, (2) on Lynn Canal near Eagle River, (3)

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[18] Muir, Mountains of California, pp. 24–26.

[19] Gilbert, *op. cit.*, p. 217.

at Gastineau Channel near Juneau, (4) near Portland Canal east of Dixon Entrance, and (5) throughout the Canadian fiords to the south. The fossils have been observed by Krause,[20] Dall,[21] Knopf,[22] Dawson,[23] McConnell,[24] and others. The fossiliferous deposits on Pyramid Island are a little over 60 feet above sea level. Those near Lynn Canal at Eagle River and Juneau are at elevations of 100 to 200 feet. They demonstrate that one of the latest, if not the last, earth movement here was an uplift of 60 to 200 feet. The marine deposits near Portland Canal at the southern border of Alaska prove the uplift there to have been nearly 500 feet. Portland Canal is 300 miles southeast of Pyramid Island. Thus it appears that there was tilting during the uplift, amounting to a foot or two per mile. There was also uplift for at least 300 miles to the south,[25] as in the Queen Charlotte Islands, at and near Texada Island,[26] and on Vancouver Island.[27]

There are no facts that appear conclusively to disprove sinking of the land in the fiords of southeastern Alaska and western British Columbia. On the other hand, there is nothing in the situation that suggests or requires it. As the evidence clearly proves a very recent and widespread uplift, it seems most natural to assume that this was not only the latest movement but also the only postglacial movement of the coast.

We conclude that Lynn Canal-Chatham Strait is a fiord in which glacial erosion, rather than faulting or normal preglacial stream erosion, has been the main agency and that sinking of the land is not an essential factor, if indeed submergence has taken place at all.

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[20] A. Krause: Das Chilcat-Gebiet in Alaska, *Zeitschr. Gesell. für Erdkunde zu Berlin,* Vol. 18, 1883, pp. 344–368; reference on p. 354.

[21] W. H. Dall: Neozoic Invertebrate Fossils, in "Alaska: Geology and Paleontology," by B. K. Emerson and Others (Harriman Alaska Expedition, Vol. 4), New York, 1904, pp. 99–122; reference on pp. 120–121.

[22] Knopf, *op. cit.*, p. 33.

[23] G. M. Dawson: Additional Observations on the Superficial Geology of British Columbia and Adjacent Regions, *Quart. Journ. Geol. Soc.*, Vol. 37, 1881, London, pp. 272–285; reference on pp. 279–282.

[24] R. G. McConnell: Portions of Portland Canal and Skeena Mining Divisions, Skeena District, B. C., *Geol. Survey of Canada Memoir 32: Geol. Ser. No. 25,* Ottawa, 1913, pp. 22–23.

[25] J. A. Bancroft: Geology of the Coast and Islands between the Strait of Georgia and Queen Charlotte Sound, B. C., *Geol. Survey of Canada Memoir 23,* Ottawa, 1913, pp. 121–123.

[26] R. G. McConnell: Texada Island, B. C., *Geol. Survey of Canada Memoir 58: Geol. Ser. No. 48,* Ottawa, 1914, p. 40.

[27] C. H. Clapp: Southern Vancouver Island, *Geol. Survey of Canada Memoir 13,* Ottawa, 1912, p. 151.

THE TERRACES OF THE LAKE MELVILLE DISTRICT, LABRADOR*

By E. M. Kindle
Geological Survey of Canada

Labrador's recent geological history has been recorded on the bleak and barren cliffs of the eastern coast in bold and legible characters. No fisherman can fail to recognize the autograph of the sea in the elevated boulder beaches and terraces of sand (Fig. 1), which may be seen in many places 200 feet or more above the present sea level and which at scores of localities look almost as fresh and perfectly preserved as those now being built by the sea. Beaches of glacial boulders such as justify Packard's characterization of "a truly noble beach" occur all the way from Hamilton Inlet to the western end of the Strait of Belle Isle, where Twenhofel[1] observed at one locality eight beaches, the highest of which was 350 feet above high tide. Terraces, however, are seen in their best development along the interior waterways. In the Hamilton Inlet and Lake Melville region they run inland more than 200 miles from the coast along the fiordlike valleys and rivers.

Terrace Building

In some localities the terraces consist of a series of great steps, the lowest of which is under water. Many of the best developed occupy the sides of stream valleys and often show considerable width. None of them represent the work of "a meandering and swinging stream, slowly degrading a previously aggraded valley;"[2] neither are they wave-cut or wave-built terraces. They have been formed in lakelike expansions of river valleys in which tidal currents were the chief factors in the movement and deposition of the sediments. The disposition of the lower or younger terraces at the head of Mulligan Bay, Lake Melville, parallel with the shore line at the head of the bay and at right angles to the direction of the river entering it, illustrates the entire independence of river activities. Here ten terraces occur within a quarter mile of the lake shore on the east side of the river, the highest lying about 25 feet above the lake.

In order to analyze the process of terrace building three factors may be considered. These are the sediments contributed by the small side streams to the trunk streams of the wide valleys, the tidal currents, and the river

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* Published with the permission of the Director of the Geological Survey of Canada. The writer's complete report on the region will be published under the title "The geography and geology of the Lake Melville District, Labrador Peninsula," as a memoir of the Geological Survey of Canada.

[1] W. H. Twenhofel: Physiography of Newfoundland, *Amer. Journ. of Sci.*, Ser. 4, Vol. 33, 1912, pp. 1–24; reference on p. 22.

[2] W. M. Davis: River Terraces in New England, *Bull. Museum of Comp. Zoöl. at Harvard College*, Vol. 38 (Geol. Ser., Vol. 5), 1902, pp. 279–346; reference on p. 284.

currents. Much of the sand drops to the bottom near the small valley mouths, where the current velocity is reduced by contact with a larger stream, and moves along the shore chiefly under the influence of tidal currents, while the fine sediment of the tributaries remains long in suspension and has a correspondingly wide and uniform distribution. Where the shore contours have been most favorable to early checking of the near shore flood currents by the ebb current, terraces have been formed if an abundant supply of sand was available. It is in the narrow near-shore zone, along which much of the coarse sediments travel and where the reversal

Fig. 1—Sand terraces at Moliak Cove, Lake Melville. Diagrammatic section of lake bottom mud and sand terraces at the right of the picture illustrate the contemporaneous development of mud and terrace deposits and progressive overlap of the former by the latter. (This and the following figures are from sketches by A. Miles and L. Kindle.)

of the tidal current first occurs, that most of the sand load is dropped and the broad flat-topped embankments are built up. "The flood current generally commences to run up the sides of a river while the ebb is still running down in the center."[3] In the Narrows at Rigolet the tidal currents attain a velocity of six to seven knots an hour in mid-channel at spring tides with very little slack water. In mid-channel the tidal streams run three and a half hours after high water by the shore. This indicates the relatively long periods of slack water along favorably located parts of the shore where the tidal current sand load may come to rest during most of the tidal cycle.

Terraces of Lake Melville and the Backway

The complexities of current behavior result often in the building of a splendid series of terraces on one side of a valley and none at all on the opposite side. This has occurred at the Narrows, where on the southeast side a series of terraces border the shore while the northwest shore is without a single terrace. Throughout most of the late Pleistocene and recent uplift of the region a deep bight has characterized the southeast shore. So long as this bight persisted the development of terraces continued as a

[3] W. H. Wheeler: A Practical Manual of Tides and Waves, London, 1906, p. 96.

result of greatly reduced current velocity in this expanded part of the Narrows. Uplift and terrace growth have now reduced the former bight to a nearly straight shore line interrupted only by one or two small spits, and terrace building is at an end on this particular stretch of shore. The youngest terrace comes to the edge of the water, but a rock reef lies below the surface instead of a growing terrace such as many localities show. The highest terrace south of the Narrows rises about one and a fourth miles back from the shore and has an elevation of 210 feet above high tide (Fig. 2). In front of it is the wide top of the next lower terrace, which is partly forested and has one or more shallow lakes and some muskeg on its approximately flat surface, which slopes gently toward the north. The front of this terrace rises gradually from 20 feet above high tide at the mouth of a brook opposite Rigolet to a maximum of 90 feet some two miles south. The face of this 90-foot terrace, as it is followed southwest from the brook mouth, is seen to split up into smaller terraces, the latest of which approaches the present shore line. Ten of these small terraces are recognizable at one point. Study of such a terrace as this, where a single terrace face splits into several minor terraces, should dispel the inference, suggested by a cursory examination of stair-step terraces, that minor terraces represent pauses in the uplift of the region. Such terraces record modified conditions of terrace development through which changes in depth, shape of shore line, supply of material, or other factors have initiated a new terrace along some part of the front of the older one.

One of the finest and most instructive sets of terraces in the region may be seen at Moliak Cove near the southwestern end of the Narrows. Here, as in the Narrows, the terraces are confined to one side of the valley. Beyond the head of the bay they continue inland for an unknown distance along a through valley now occupied only by a small lake and brook (see Fig. 1). At this locality three well developed terraces rise respectively 12 feet, 120 feet, and 310 feet above high tide. A fourth poorly defined terrace stands at about 20 feet. A fifth, the youngest of this series, is now being built just below or partly below low tide. It extends out from the foot of the first subaerial terrace from 10 to 75 yards and then descends to deep water and mud bottom with the same steep grade as the fossil terraces inshore from it.

Underwater terraces are now forming along parts of the bottom of the Backway, which is a finger lake type of valley closed seawards but connected with Lake Melville. Most of the terrace building along the Backway basin has taken place on the south side of the waterway. Its best development is seen a few miles below the entrance. The sketch (Fig. 3) shows at this locality a main or highest terrace rising 310 feet A. T. (aneroid) connecting together in bar fashion two Precambrian hills. Between this major terrace and the shore about six minor terraces are recognizable. Some of these are modified by sand spits developed during the withdrawal of the sea.

FIG. 2—General view of the south side of the Narrows, showing sand terraces.

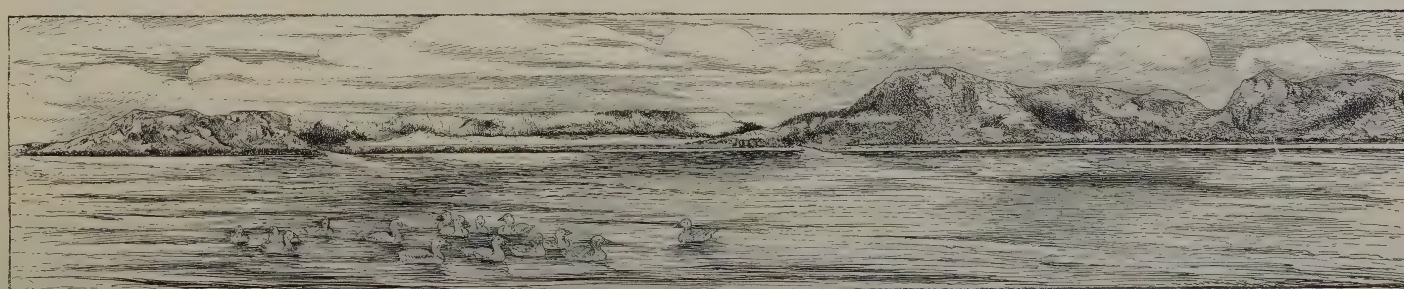

FIG. 3—Sand terraces connecting hills of Precambrian rocks on the west side of the Backway.

The upper end of the Lake Melville basin, known as Goose Bay, is being rapidly filled with sand annually poured into it by the Hamilton River during the flood season. Tidal currents distribute the sand around the margin of the basin as it is received, forming a continuous subsurface terrace shelf, which is generally from one-half to two fathoms under water and from one-quarter to two miles wide. This growing terrace surrounds a basin that ranges in depth from 8 to 34 fathoms. In case the present stage of emergence is maintained for a long period, Goose Bay will be filled to a level sand plain with the Hamilton River flowing through the middle and joining the lake some 15 miles to the eastward of the present mouth. At the eastern end of Goose Bay the 16,000-foot passage into Lake Melville has already been largely closed by the encroaching underwater terraces, which now leave a channel only about half a mile wide and two and a half miles long. In case emergence continues as it has during late Pleistocene times, the building of a series of terraces will accompany the extinction of Goose Bay.

River Valley Terraces

In the river valleys, as a result of elevation of the land and the retreat of the lakelike tongues of the sea, terrace building is at an end. But the great fossil terraces rising often 200 feet or more above the rivers remain. Along the valleys of the Naskaupi and its western tributary, the Red River, terraces are splendidly developed in places. A short distance above the mouth of the Naskaupi a mid-valley, or island, terrace area has developed as a result of the junction of the Little River and Naskaupi River valleys. Four terraces mark this island, rising above low water in the river 8, 58, 78, and 103 feet. Another great sand terrace rises just above the junction of the Red and Naskaupi valleys with an elevation of 200 feet above the rivers.

The highest terrace observed at a considerable distance from the coast was seen west of the Naskaupi a few miles up the Red River, where the terrace top rises 280 feet above the river. If allowance is made for the grade of the river valley this figure is very close to the elevation of the one at Moliak Cove.

Significance of the Terraces

The conditions that have been shown to control the development of terraces in this region are local in character. Consequently the correlation of terraces other than those representing the maximum submergence is impracticable. Terraces formed at different stages of uplift represent only terrace conditions that appear and disappear in conformity with certain topographic adjustments to the water level.

The two maximum terrace measurements (aneroid) made in the region are both recorded at 310 feet. It is probable that the maximum submer-

gence did not exceed this figure more than 15 feet, so that 325 feet may be considered a close approximation to the maximum submergence experienced by this region during Pleistocene times. This figure is a little higher than Daly's estimate[4] of the maximum amount of the emergence in the Hamilton Inlet district, which was based on other kinds of evidence.

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[4] R. A. Daly: The Geology of the Northeast Coast of Labrador, *Bull. Museum of Comp. Zoöl. at Harvard College*, Vol. 38 (Geol. Ser., Vol. 5), 1902, pp. 203-270; reference on p. 259.

ANTARCTIC GLACIERS

By Harry Fielding Reid
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The volume "Glaciology" of the British (Terra Nova) Antarctic Expedition[1] contains an immense number of observations on the various types of ice and glaciers of Antarctica. The large scale of the Antarctic continent, the continuously low temperatures, and the severe blizzards prevented the making of repeated visits to the various glaciers so that intensive studies of them were impossible; but one can only admire the energy, pluck, and endurance that were necessary to collect all the information contained in this volume.

From this and other expeditions we can form a fairly good general conception of the Antarctic continent and its characteristics. But it must be remembered that exploration has only touched the coast here and there. The continent has an area of about 5,000,000 square miles; it is approximately circular, with two known deep indentations, the Ross Sea and the Weddell Sea, nearly opposite each other. It is roughly centered about the pole. The surface rises gently from the coast to a height of nearly 10,000 feet near the pole and is nearly all covered with ice and snow. South of New Zealand a great fault runs towards the pole letting down a block covered by the Ross Sea and Ross Barrier. King Edward VII Land seems to bound this block on the east, but little is known of it. The fault bends around to the southeast near the parallel of 80°, and no information regarding it is available beyond the meridian passing through the east side of the Ross Barrier. The region along the fault zone is known as South Victoria Land. The zone itself is a scarp leading from sea level up to the high plateau; and along the zone rise high mountains, up to 15,000 feet. Ice overflows from the plateau and streams down across the zone in a few large glaciers. Smaller glaciers rise on the flanks of the mountains in the zone itself. The glaciers tapping the plateau, and some others, have very small gradients. The Beardmore Glacier, the largest known valley glacier in the world, with a length of 120 miles and a breadth varying between 15 and 35 miles, has an average gradient of about two-thirds of a degree. The region explored by the British Expedition embraces an extent of about 1000 miles in the neighborhood of the fault zone, about 300 miles of the high plateau in the neighborhood of the pole, and a part of the plateau farther north.

The authors describe the various characteristics of the glaciers and emphasize the considerable differences between them and glaciers of the

[1] British (Terra Nova) Antarctic Expedition (1910–1913): Glaciology, by C. S. Wright and R. E. Priestley. 581 pp.; maps, diagrs., ills. Harrison & Sons, Ltd., for the Committee of the Captain Scott Antarctic Fund, London, 1922.

temperate zone. The numerous excellent half-tones and figures in the text, many of them diagrammatic, add much to the clarity of the descriptions. We shall attempt to see what light their observations throw on the general theory of glaciers.

Parts of a Glacier

A complete glacier consists of two parts, the reservoir, where there is accumulation and the dissipator, where there is wastage; these regions are separated by the *névé* line, and there is continual flow from the first to the second. The general directions of the lines of flow are known and clear

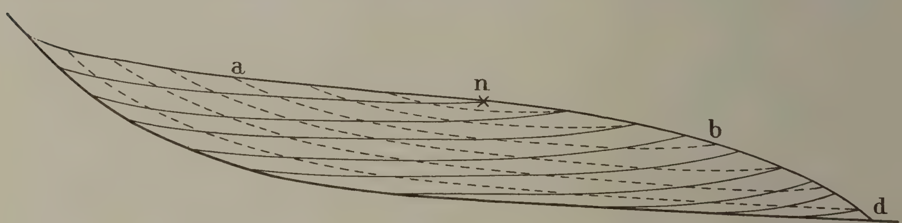

Fig. 1—Diagram showing lines of flow (broken) and lines of stratification (solid) of a glacier.

up many phenomena.[2] They and the strata are shown diagrammatically in the figure. Each point of the reservoir where snow is collected is connected by a line of flow with a corresponding point in the dissipator, where that same snow, converted into ice, is dissipated. The higher up the beginning of a line of flow is in the reservoir, the farther down its end lies in the dissipator; and the snow that accumulates at the very head of the reservoir only comes to the surface at the end of the glacier. In the reservoir the movement has a component downward into the glacier, in the dissipator towards the surface.

It is convenient to divide glaciers into two classes—complete and incomplete. All the accumulation of a complete glacier is lost by ablation and melting in the dissipator. In an incomplete glacier a part of the dissipator is missing, either because it falls over a cliff or because it breaks off and floats away as icebergs. The surface phenomena of the reservoir and of the dissipator are quite different.

All the large glaciers of the Antarctic, and especially those that tap the plateau ice, are incomplete and consist almost entirely of the reservoir only; though in places stretches of the dissipator exist. A large proportion of the observations of the explorers, therefore, refer to the reservoir; this is fortunate, for the reservoirs of temperate glaciers have received much less attention than the dissipators.

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[2] S. Finsterwalder: Der Vernagtferner, *Wiss. Ergänzungsheft zu Zeitschr. Deutsch. und Oest. Alpenvereins,* Vol. 28, 1897.

H. F. Reid: The Mechanics of Glaciers, *Journ. of Geol.,* Vol. 4, 1896, pp. 912–928.

Idem: De la progression des glaciers, leur stratification et leurs veines bleues, *Compte-Rendu Congrès Géol. Internatl. VIII, Paris, 1900,* pp. 749–755.

Accumulation

Anticyclonic conditions prevail in the Antarctic because of the large expanse of snow-covered surface. The air, rendered cold and heavy by contact with the snow, slides down the slopes radially and is deflected to the left by the earth's rotation, so that southeasterly winds predominate, especially during blizzards. But the large valleys of the fault zone guide the winds locally so that in this region the blizzards blow from the west. These winds are of great violence and blow off much or all of the snow from the valley portion of the glaciers and deposit it again lower down or carry it out to sea. As the air slides down the slopes its place is taken by descending currents, which become heated adiabatically and bring about much ablation.

We thus understand how in certain regions the annual ablation is greater than the deposit and how parts of true dissipators exist, with their normal characteristics, in spite of the fact that even the summer temperature of the Antarctic continent is below the freezing point. Indeed some stretches of dissipator are practically free of snow throughout the year. Without the winds the snow line would lie everywhere at sea level. The accumulation of snow is very spotty and depends much on the local topography. Its amount is small. The recovery, after six and a half years, of an old *dépôt* on the Barrier showed an annual accumulation of about 15 inches of snow of specific gravity 0.5, or 7½ inches of water. In some sheltered places it must be more, in some places less; and, as noticed, in places ablation predominates. The heaviest snowfalls seem to come from gentle northwest winds, which bring moisture from the warmer ocean; as much as 17 inches of snow fell in one such storm. The snowfall is heavier near the borders of the continent than it is farther south; but the accumulation is patchy and depends on the winds. The drift snow on the lower stretches of the glaciers may be looked upon as the reservoirs of parasite glaciers such as may be seen in complete form in the Swiss Alps. The snow on the high plateau is soft and incoherent; it seems to be like the snow sometimes encountered in the high Alps when cold weather follows a storm; or like that found by Whymper on the top of Chimborazo. The authors think there is a very small accumulation on the high plateau. That the ice is flowing down the plateau is evident from the behavior of ice on a slope, the existence of crevasses on the slopes, and the actual measurement of the movement by Drygalski near the Gaussberg.

Ablation

This term refers, not to the disappearance of recently fallen snow, but to the loss of older ice from the dissipator. The principal causes of ablation are direct or reflected solar radiation, reradiation from heated rocks, condensation of moisture from the atmosphere, rain, and the sublimation of ice. Condensation of moisture is an important factor with temperate

glaciers and deserves more emphasis than it has received. I think it has much to do with the rounding of angles, such as the edges of crevasses, etc. In the Antarctic it acts differently: any condensation is in the form of hoarfrost, ice flowers, etc., and is a means of accumulation (though insignificant) and not of ablation. Rain is practically unknown in Antarctica. The authors ascribe to sublimation of the ice by the warm dry winds blowing down the valleys a principal rôle in the ablation of Antarctic glaciers; it is quite unimportant in temperate zones. But the most striking effects are due to radiation. The sun never rises high in Antarctica, but it shines for long hours in the summer. Its rays strike the ends of the glaciers at a high angle; and, especially where silt bands are abundant and add to the absorption, the ablation is strong. As the silt bands predominate at the lower levels of the ice and as the upper layers move more rapidly than the lower, a somewhat overhanging cliff is developed; and from time to time ice breaks off the upper part and falls to the ground. The form is not confined to the ends; but reflected radiation and reradiation from the walls of the valley develop the same form along the sides and leave the so-called "radiation gully" between the ice and the valley sides. This gives to the smaller glaciers of northern Greenland and Antarctica a striking appearance, which is never seen in temperate latitudes. It is rather remarkable that this form may not only be one of equilibrium, but it may be stable; whereas the rounded ends of temperate glaciers are unstable.

Absorption of radiation by thin moraines, by small stones and dust, is extremely effective in melting the ice. During a few days in summer a considerable quantity of water runs off the surface. The melting is naturally selective, being confined to the immediate vicinity of the débris, and cliffs and pinnacles of fantastic shapes result. These are well developed on the northern side of the lower part of the Koettlitz Glacier, where the heights of the cliffs and pinnacles and the existence of surfaces of discontinuity suggest that we have here the results of many seasons' ablation.

Moraines

The explorers were struck with the scarcity of moraines in the Antarctic. This is due to two causes: the small amount of exposed rock and the fact that nearly all the region is reservoir. Moraines do not remain exposed in the reservoir in any latitude; however, the annual accumulation is so small in the Antarctic that a moraine may be exposed on the surface of the reservoir for a short distance from its origin before it is covered up. A moraine may appear on the stretch of dissipator, be covered by the drifted snow lower down, and again appear farther on—thus giving the curious phenomenon of an intermittent moraine.

Moraines without evident origin also were seen on the dissipator or in the terminal face of a glacier. The explorers were inclined to consider the first as due to the upturning of the strata or to ground moraine brought to the

surface by shearing of the ice, as Chamberlin has suggested; and the latter as due to such shearing or to the sinking of stones through the ice by their own weight. The explorers found, however, little evidence in support of their hypothesis, and our figure shows that it is unnecessary. Suppose there is at *a* a junction of two tributaries, or the reunion of the ice after passing around a nunatak; as the ice flows on, the inner boundaries of the two branches, with their ground moraines, will form a highly inclined wall strewn with moraine and extending downwards from *abd* to the bed of the glacier; but no moraine will appear at the surface between *a* and *b*. This, I think, is the complete explanation of medial moraines starting at some point of the dissipator and growing greatly as more material is melted out of the ice. The great medial moraines of the Aletsch Glacier are excellent examples. In the reservoir the snow usually slopes up against the mountains, and individual stones may slide or roll well out upon the glacier and later come to the surface, or to the terminal face, away from the moraine. Sometimes a slide of rocks may be shot out upon the reservoir and be incorporated in the glacier spread out upon a stratum. It will come to the surface in the dissipator in a form somewhat different to that of a medial moraine. When two glaciers unite, the strata are necessarily bent up; and, as mentioned, the surface of junction contains some ground moraine. Even under the large medial moraines of Alpine glaciers this junction is not heavily filled with moraine material; the very small amount seen in the Antarctic glaciers strengthens the conclusion, reached by the explorers, that these glaciers are not now greatly abrading their beds. The highly inclined dirty bands seen on the ends of glaciers or on the sides of icebergs probably mark the junction of glaciers. The moraines on the dissipator are quite normal. Where the material is scarce and its component blocks are not large, it is apt to melt into the ice; where the material is sufficient to protect the ice it forms ridges. Large blocks stood up as glacier tables. Very little ground moraine was seen. The larger glaciers end in the sea, and the base is invisible; the small glaciers ending on land are probably frozen to their beds. Lateral moraines, which are characteristic of the dissipator, also were scarce, because the rock falling from the mountains fell, for the most part, into the radiation gully and not upon the ice. Where the gully had been filled with drifted snow some lateral moraine was formed.

Glacier Grains

The explorers made many interesting and valuable observations of the development of ice crystals under different meteorological conditions, but we must reluctantly pass them by. They studied the transformation of snow into ice in the glaciers and introduce a useful distinction between *névé* snow and ice. There is much air between the fallen snow crystals; as long as this air remains between the growing crystals, we have *névé;* but, when the crystals have grown and include the air bubbles, we have

ice. They found the glacier grains similar to those in temperate glaciers but smaller; and they refer this to the very low temperatures of the Antarctic. They discuss at length the growth of these grains, and, as there can be no question of melting here, they adopt Chamberlin's view that molecules of ice pass from crystal surfaces of larger curvature to those of smaller curvature. No other explanation is at hand, but this one presents difficulties. It would lead to the formation of plane faces between the crystals, and growth would then cease. In the Antarctic, as in temperate zones, glacier crystals interlock. We often find a small extension of one crystal completely surrounded by another crystal. It is exactly in condition to be rapidly absorbed, but such interlocking is common and not exceptional. The most effective condition for the growth of crystals is the presence of water, which, of course, brings the ice to the melting temperature; and many examples are cited. But the mere presence of ice may convert the snow in contact with it into ice. When wind or solar radiation makes a thin film of ice on the surface this film may grow in thickness at the expense of the snow about it. The explorers even found that such a film could grow after it had been covered over with fresh snow; but it had its inception at the surface and would mark the stratification of the snow. A glance at our diagram shows that such a system of blue bands would appear at the vertical end of the glacier as nearly horizontal lines, separated by ice containing more air; for blue bands are merely layers of ice free, or nearly free, of air. Only in exceptional cases does the ice of Antarctic glaciers suffer much contortion, so that the banding at the glaciers' ends is usually simple. The influence of solar radiation in originating the banding is shown by the fact that the banding is better developed as the latitude is lower. Clearly there will be a limit to this, a limit which apparently is not reached in Antarctica. In the lower parts of the larger Swiss glaciers the transformation has proceeded so far that the ice in general consists of large crystals, the blue banding has been obliterated, and the stratification has disappeared.

The explorers discuss the mechanism of the flow of the ice and accept Chamberlin's view (in part at least) that it depends on the movement of "mobile" molecules and is related to the growth of crystals.

Silt Bands

About thirty years ago Chamberlin brought prominently to the attention of glacialists the vertical ends and sides of the glaciers of northern Greenland and the system of silt bands that appeared on these faces. He interpreted the bands as material picked up from the bed and brought into their present position by a series of shears, the successive layers of the glacier slipping over those underlying them. He actually saw one place where ground moraine was being incorporated into the ice; and Case made some

experiments that showed this was possible.[3] But the bands produced in this way were materially different from the systematic series. The Antarctic explorers found precisely similar series of bands in the Antarctic glaciers and made important observations which, I think, offer an entirely satisfactory explanation. They found that banks of drifted snow were in many cases made up of layers separated by silt bands, and the edges of the banks weathered like the ends of the glaciers. That the silt bands represented merely dust blown upon the surface of the snow was confirmed by the presence of penguin feathers and dead seaweed. On the eastern side of Robertson Bay (just west of Cape Adare), where the easily weathered volcanic rocks furnished large quantities of finely disintegrated rock to the winds, the bands were highly developed in drifts and glaciers; and on the western side of the Bay, where the rocks were much harder, the bands were less prominent.

Owing to the varying directions of the winds, the surface of the snowbanks was often carved into very irregular forms upon which were deposited more dust and more snow, showing marked unconformities and giving the appearance of contorted movements, which had not taken place. The confident conclusion of the explorers that the silt bands originate in dust blown on the surface of the glacier is supported, as in the case of the blue bands, by a glance at our diagram, which shows that the strata will lie roughly parallel with the glacier's bed and that their edges at the terminal face will be roughly horizontal lines except where the ice has been tortured into contorted movements or broken through by many crevasses—and these accidents are not very common in the Antarctic. The many striking unconformities seen on the glaciers and on icebergs receive here their full explanation.

Some silt bands are ascribed to dust blown into a crevasse which afterward closed. A diagram represents the suture of such a closed crevasse as a straight line gradually becoming more and more inclined on account of the greater velocity of the upper layers of the glacier, but the diagram is not exactly correct. On account of the differential velocity the vertical suture would be changed into a curved line, concave upstream. It would appear as a curved line on the side wall of the glacier, nearly horizontal at the bottom, curving well up into the upper layers, and ending at the line of flow which originated at the surface where the crevasse was closed; if the suture intersected the end face of the glacier, not too near the base, it should dip into the ice at a fairly high angle. Nothing of this kind was reported. It should also cut across the silt bands that mark the stratification. This may be the explanation of the apparent but somewhat doubtful crossing of silt bands shown in Plates 150 and 163. If a glacier were

[3] T. C. Chamberlin: Recent Glacial Studies in Greenland, *Bull. Geol. Soc. of America*, Vol. 6, 1895, pp. 199–220.

Idem: Glacial Studies in Greenland, *Journ. of Geol.*, Vol. 3, 1895, pp. 61–69, 198–218, 469–480, 565–582, 668–681, and 833–843.

E. C. Case: Experiments in Ice Motion, *ibid.*, Vol. 3, 1895, pp. 918–934.

greatly riven by crevasses, silt bands formed in this way would lose all regularity.

Chamberlin's authority leads the explorers to consider the possibility that the material of the lowest silt bands is incorporated ground moraine, though they recognize that the universality of these bands, their uniformity, and their similarity to the bands higher up in the ice offer special difficulties. I can see no necessity for this view; and it is to be noted that the explorers found no evidence that the layers of ice slipped along the silt bands. Our diagram shows that the bottom layers of the glacier originated at its head, where, in the case of cirques, much dust would accumulate. Moreover, the greater differential motion of ice near the glacier's bed would thin out the strata and bring the silt bands closer together. It must also be remembered that the ice near the bed is very old; the mean temperature of Antarctica is so low that the thinner glaciers would be frozen to their beds, making the velocity there so small that we must place the origin of this ice very far back in the past; is it not possible that when the silt of these bands was accumulated there may have been more disintegrated rock available?

Classification of Land-Ice Formations

The explorers have classified the Antarctic ice into four main types, namely, ice occurring in (1) the area of predominant supply, (2) the area of predominant movement, (3) the area of predominant wastage, and (4) the area of balanced forces. The ice of the high plateau, ice caps, and snowdrifts come under type 1; the valley portions of glaciers under type 2; the lower portions, piedmont ice, ice tongues, under type 3; and shelf ice under type 4. They have found this classification convenient for their descriptions; but it is not well adapted for the theory of glaciers. A large glacier may belong to all four types. For general purposes it would be better to divide a glacier into reservoir and dissipator, for each of these parts has distinct characteristics, and they are fundamentally related to the very existence of the glacier. Of course, the explorers recognize the relation, but they do not specifically emphasize it.

We have already discussed some of the types; and we shall now take up some others.

Piedmont Ice

Russell introduced the term, piedmont glacier, to describe the expanded ends of valley glaciers that coalesce at the foot of the mountains. The Malaspina Glacier is the classic example, and it is wholly dissipator. The two piedmont glaciers described in the Antarctic lie on shelves between the mountains and the sea; the explorers think they originated by the coalescence of the valley glaciers. This may be so, but the maps and the descriptions show that they no longer derive their supplies in this way but from snow accumulated on their surfaces. They lie wholly, or almost

wholly, in the region of supply; and they waste by melting in the sea water, by breaking off at their terminal cliffs, and, perhaps to a slight degree, by melting or sublimation at the surface. They only resemble Russell's type in their locations. Would it not be better to look upon them as individual and independent glaciers?[4]

Ice Tongues

Where an actively moving glacier reaches tidewater at a low gradient, it usually sends out a tongue which floats on the water to a distance of many miles. It stands up from a few feet to 200 feet above the water and is bounded on all sides by vertical cliffs. The calving of bergs on the sides naturally narrows the tongue as it advances so that it takes the shape of a triangle with the base at the coast line. Some of these tongues are of great size; the Shackleton tongue, on the northern coast, has a breadth at its base of nearly 200 miles and projects an equal distance beyond the coast. The Drygalski and the Nordenskjöld ice tongues project from the great scarp into the Ross Sea; and there are many smaller ones. The Mackaye ice tongue, in Granite Harbor, and the Erebus Bay ice tongue, on the southwest side of Ross Island, are each six or seven miles long; the former is about three miles wide, and the latter a little more than one mile. Their sides are nearly parallel. They owe their extension and shape, apparently, to their sheltered positions. The Mackaye tongue enters the head of the harbor, which, in winter at least, is entirely frozen over. Its movement was measured and found to be nearly three feet a day. The shores of the harbor are nearly parallel with the glacier tongue; and cracks, designated as shear cracks, occur in the fast ice (the frozen sea water), running from the shore to the tongue and pointing upstream at an angle of about 45°. These cracks all start from projecting points of the shore, and the explanation is simple. The fast ice is frozen to the shore and to the tongue. As the latter moves forward tensions and pressures are developed in the fast ice like those on the sides of valley glaciers, which produce the marginal crevasses. The greatest pressure is parallel to the direction of the cracks and forces the fast ice into pressure ridges at the shore. Beyond a projecting point the retreating shore line allows the ice to move on, thus starting a shear crack, and the tension at right angles to it may open it to a considerable width. The pressure ridges about the Erebus Bay ice tongue indicate a velocity comparable to that of the Mackaye.

Shelf Ice: Ross Barrier

In some parts of the Antarctic there are sheets of fairly level floating ice ending in vertical cliffs, and their surfaces are continually accumulating snow. Nordenskjöld called them shelf ice. The explorers explain them as due to the coalescence of floating glacier tongues, to the accumulation

[4] The explorers recognize these differences and adopt the name tentatively.

of snow on fast ice, or to a combination of the two processes. It is thus that the great Ross Barrier, the most notable example of them all, was developed during the advancing stages of the glacial cycle; and now, during the waning stages, it is gradually being destroyed. It is nourished by the great glaciers that pour into it on its landward sides and by the accumulation of snow on its surface, which we have seen amounts annually to something like 15 inches of snow of specific gravity 0.5. It is losing ice by the calving of icebergs from its face and perhaps by melting at its under surface in contact with the salt water. Its cliffs face the sea for a distance of some 400 miles, and it stretches nearly as far southward to the great scarp, thus covering a great gulf in the Antarctic continent. Soundings in front of the face show depths of 300 to 400 fathoms. Its surface is practically level, though characterized by many gentle undulations, which cause the cliffs at the face to vary in height from 6 to 160 feet above the sea. The movement of the old *dépôt* showed that it is advancing with a velocity, near its western border, of about 1500 feet a year; but there are no crevasses except near the borders and near the mouths of the glaciers. When the *Nimrod* was moored alongside the face, the ice was found to rise and fall with the tides; so that it seems fairly evident that the Barrier is afloat over all or nearly all its area.

The position of the face at present is not one of equilibrium. From 1841 to 1902 it has broken back about 25 miles; and, since the ice has advanced about 17 miles in the same period, we see that the ice has been broken off to a depth of about 42 miles, that is the calving of icebergs has been more than twice as great as the movement. For equilibrium the two must be equal; but it does not seem probable that the equilibrium would ever be stable; an increase of velocity would not cause a greater calving, nor would a change in the rate of calving affect the velocity, so that the position of the face must always be changing and must depend very largely on its previous history. It must at some time have extended considerably further north than it does now; how far we do not know.

The explorers think the rate of calving is largely influenced by the melting in contact with sea water. May not the frequency and violence of storms be a more important factor? The Barrier is capable of adjusting itself to the movement of the tides without calving; but the greater range of storm waves, and their shorter period, would seem to be particularly effective for calving. The long and narrow Erebus Bay tongue maintained itself, in its protected situation, almost unchanged from 1902 to 1911; but during an unusually severe blizzard in the latter year, nearly half its length broke off and floated away as a great iceberg. I do not believe either the Erebus Bay or the Mackaye tongue could survive if subjected to the storm waves of the northern coast.

Sponges, shells, and mirabilite (sodium sulphate) deposits were found in several places on the surface near the ends of glaciers. Their character and appearance negatived the idea that they had been dropped on the ice,

and Debenham[5] supposed that they had been incorporated into the ice at its under surface and been gradually brought to the upper surface by ablation above and by growth due to freezing below. The explorers accept this explanation, but it seems hardly compatible with melting at the under surface of the Ross Barrier. It would have required much more intense cold. The Barrier undoubtedly was larger in the past, and the ice at other parts of the shore may have extended farther out upon the ocean; but was the temperature any lower than it is now? Indeed, could it have been any lower? Are not present conditions such as to produce as low a temperature as we could ever expect on the earth?

The two forms, the floating glacier tongue and the floating shelf ice, are peculiar to the Antarctic; they are unknown elsewhere. The explorers, reasoning by elimination, reach the conclusion that the absence of such forms in the Arctic is due to the warmer summer temperatures of the sea water there accompanied by more rapid melting and more rapid calving. There is another difference which was not noticed in this connection, namely, that the Greenland icebergs calve from the dissipator, where the ice has a high density, nearly 0.9, and is made up of glacier grains; the Antarctic icebergs calve from the reservoir and are made up largely of snow ice of lower density. Drygalski[6] has described the formation of a large berg at the end of the Great Karajak Glacier. His observations indicate that the glacier, progressing down a gentle slope, forces the end into the water to a lower level than the natural level of flotation and that the buoyancy of the water at last breaks it off. It then rises to the proper level and floats away. The explorers of Antarctica describe the continual accumulation of snow on the many ice tongues and on the shelf ice, and the melting at the under surface, until at their outer ends the whole thickness may consist of snow ice only. The stratification is shown primarily by the layers containing different amounts of air. Many of the large icebergs that have tilted show that their lower layers consist of this snow ice. The rise and fall of the ice with the tides show that it is flexible enough to adjust itself to the proper level of flotation quite rapidly. May not this flexibility, which does not seem to be shared by the Greenland ice, account for the existence of ice tongues and shelf ice in the Antarctic? And may not the greater flexibility be due to the less compact and less crystallized ice of the south?

Geologic Climates of Antarctica

An examination of the rocks, the fossils, and especially the paleobotany of Antarctica brought out pretty clearly that before the Tertiary the climate of the region was decidedly mild. Glaciers may have existed at times but apparently did not attain any great expansion. During the

[5] Frank Debenham: A New Mode of Transportation by Ice: The Raised Marine Muds of South Victoria Land (Antarctica), *Quart. Journ. Geol. Soc.*, Vol. 75, 1919, pp. 51–76.

[6] Erich von Drygalski: Grönland-Expedition der Gesellschaft für Erdkunde zu Berlin, 1891–1893, 2 vols., Berlin, 1897: reference in Vol. 1, pp. 391–392.

Permo carboniferous glacial period of lands in the southern hemisphere Antarctica seems to have enjoyed a temperate climate. There are some unsatisfactory indications of refrigeration in the Eocene; but it was not until the Pliocene that great ice sheets were developed; and they have continued, without clear evidence of interglacial periods, until the present day. As the explorers conclude, "glacial conditions have been the exception and not the rule in Antarctica." They place the time of maximum glaciation in the Pleistocene and bring forward much evidence showing the recent rapid dwindling of the ice. High level moraines and erratics have been found several hundred, and in cases one or two thousand, feet above the present ice in their neighborhood. Dry Valley, once filled with ice, is now quite bare; the same is true of other places. That the retreat is still in full swing is shown by the moraine-covered stagnant ice on the side of Koettlitz Glacier to a height of a thousand feet and by the remains of piedmont glaciers cut off from any supply and gradually disappearing. The retreat of Ross Barrier since Ross's visit in 1841 is also striking.

In discussing the cause of ice ages the author (Wright) has, without reaching any definite conclusion, been led pretty far afield; but this may be necessary, for certainly no convincing explanation of ice ages has yet been offered.

The volume on "Glaciology" is full of interesting and important observations and deserves the careful study of glacialists. I have been obliged to pass by much and to confine myself almost entirely to observations bearing directly on the theory of glaciers. The Antarctic observations do not conflict with the theory as generally accepted; they throw light on some questions, especially concerning the reservoir, that have been matters of controversy; and they describe characteristics peculiar to climatic conditions unknown in other parts of the world.

THE TERRITORIAL ORGANIZATION OF THE SOVIET POWER, 1924

By Robert F. Kelley
U. S. Department of State

The early part of the present year witnessed the completion of the territorial reorganization of the Soviet power which was entered upon in December, 1922, by the conclusion of a treaty between the four so-called Soviet Republics, known as the Russian Socialist Federated Soviet Republic, the White Russian Socialist Soviet Republic, the Ukrainian Socialist Soviet Republic, and the Trans-Caucasian Socialist Federated Soviet Republic, creating a new international entity to be known as the Union of Soviet Socialist Republics. The relations between the four States of the Union are defined by a Constitution promulgated on July 6, 1923, and definitively confirmed by the Second Federal Congress of Soviets on January 31, 1924. Prior to the creation of this new entity the territories of the former Russian Empire were occupied by a number of theoretically independent political units—the Russian Socialist Federated Soviet Republic, the Ukraine Socialist Soviet Republic, the Socialist Soviet Republic of White Russia, the Socialist Soviet Republic of Azerbaijan, the Socialist Soviet Republic of Armenia, the Socialist Soviet Republic of Georgia, the Far Eastern Republic, the Khivan People's Soviet Republic, and the Bukharan People's Soviet Republic.

The center of this group was the Russian Socialist Federated Soviet Republic, which, while formally recognizing the independence of the various Soviet republics, effectively directed and controlled the foreign policy and main lines of internal development of the several states. Azerbaijan, Georgia, White Russia, and the Ukraine were bound to Soviet Russia by treaties of military economic alliance, providing for the unification of various departments of the respective governments—Foreign Trade, Finance, Army and Navy, Means of Communication, Post and Telegraph, Labor, etc. With the Far Eastern Republic there existed merely an economic alliance, and with Armenia there existed an agreement introducing the financial system and regulations of Soviet Russia into Armenia. With Bukhara and Khiva, Soviet Russia had concluded simply treaties of alliance which made no provision for unification of governmental organs. It is to be noted that each of these states conducted its own foreign relations. At the time of the Genoa Conference (1922), for instance, a protocol was drawn up between Soviet Russia on the one side, and Azerbaijan, Armenia, White Russia, Bukhara, Georgia, the Far Eastern Republic, Ukraine, and Khiva on the other, authorizing Soviet Russia to represent and defend their interests at the European Economic Conference. The Constitu-

tion of July 6, 1923, consecrates this supremacy of Moscow and attempts to create a systematic organization in which the relations between the various Soviet States are carefully defined. A single international entity is thereby created, which the Bolshevik leaders believe can more effectively further Soviet interests than the several quasi-independent units that had existed hitherto. Thus from one point of view the creation of the Soviet Union may be considered as marking the reintegration of the various parts of the former Russian Empire, which had tended to escape from the control of Moscow during the period of civil war. On the other hand, it represents the creation of a form of political organization best adapted in the eyes of the Bolshevik leaders to the realization of their aims in the future. Admission to the Union, as the Preamble of the Constitution states, is "open to all Socialist Soviet Republics such as are now existing and such as shall arise in future," and the new Federal state is declared to be a decisive step towards the "union of the toilers of all countries into one world Soviet Socialist Republic."

The present international entity, therefore, is the Union of Soviet Socialist Republics, not Russia, nor the Russian Socialist Federated Soviet Republic.[1] The word "Russia" in so far as it is used by Soviet writers is restricted to the activities of the Russian Socialist Federated Soviet Republic, which is one of the component states of the Union; the Bolsheviks are very careful not to apply it when referring to the activities of the Soviet Power. The Soviet Union, as we have seen, is composed of four constituent republics. These in turn are composed of subordinate ethnic units,[2] all of which have representation in the Soviet of Nationalities, the upper chamber of the Federal Central Executive Committee, the supreme political authority in sessions between the Federal Congresses of Soviets. The first Soviet of Nationalities, elected on February 2, 1924, consists of one hundred members comprising five delegates each from six constituent republics, five delegates each from eleven autonomous republics, one delegate each from ten autonomous regions, and one delegate each from five autonomous areas in the Caucasus.

Russian Socialist Federated Soviet Republic (1–22)[3]

The Russian Socialist Federated Soviet Republic, which includes by far the largest part of the former Russian Empire, is the largest state in the Union, having an area of about 7,920,000 square miles with a population of about 97,000,000. Soviet Russia is composed of two groups of territorial subdivisions—provinces (1) on the one hand and, on the other, autonomous areas designated either as republics or regions (*oblasti*) with a certain

[1] The word "Russian" was erroneously inserted in the name as given in the *Geographical Review*, Vol. 14, 1924, p. 273.—Edit. Note.

[2] For a brief description of the principal ethnic stocks of European Russia in relation to the political subdivisions of Soviet Russia of 1923, see the *Geographical Review*, Vol. 14, 1924, pp. 270–274.

[3] Numbers in parenthesis correspond with numbers on maps, Figures 1 and 2.

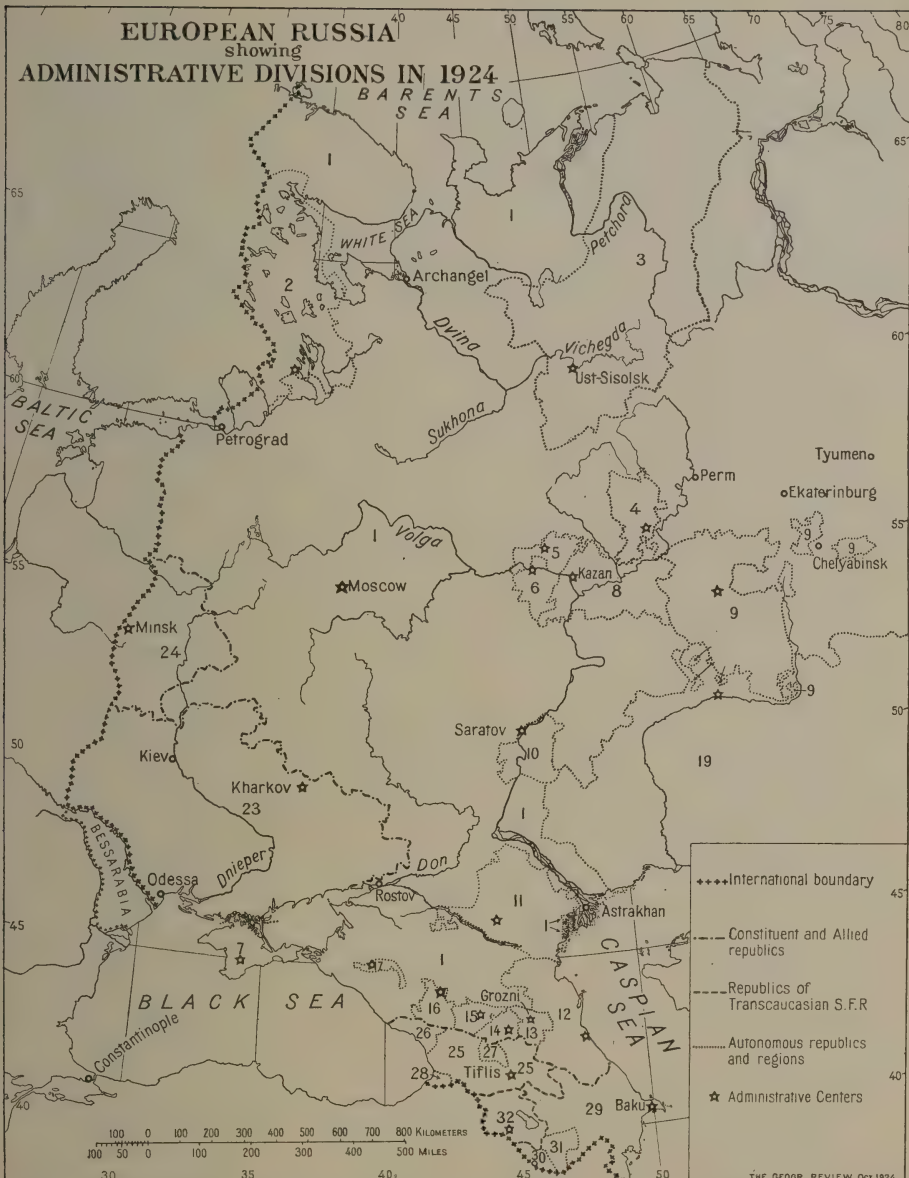

FIG. 1—Map of European Russia showing political subdivisions in 1924. 1–17 incl., Russian Socialist Federated Soviet Republic: 1, part of R. S. F. S. R. subdivided into provinces; 2–17 incl., autonomous republics and autonomous regions (*oblasti*) of the R. S. F. S. R. as follows: 2, Karelian Republic; 3, Ziryan (Komi) Region; 4, Votyak Region; 5, Mari (Cheremiss) Region; 6, Chuvash Region; 7, Crimean Republic; 8, Tatar Republic; 9, Bashkir Republic; 10, Republic of the Volga Germans; 11, Kalmuck Region; 12, Daghestan Republic; 13, Chechen Region; 14, Mountain (*Gorskaya*) Republic; 15, Kabardino-Balkar Region; 16, Karachaevo-Cherkess Region; 17, Cherkess-Adighé Region. 23, Ukrainian Socialist Soviet Republic. 24, White Russian Socialist Soviet Republic. 25–32 incl., Trans-Caucasian Socialist Federated Soviet Republic. 25–28 incl., Georgian Socialist Soviet Republic, comprising: 25, Georgian S. S. R. proper; 26–28 incl., autonomous republics and autonomous regions of the Georgian S. S. R. as follows: 26, Abkhazian Republic; 27, South Osetian Region; 28, Adzharian Republic. 29–31 incl., Azerbaijan S. S. R., comprising: 29, Azerbaijan S. S. R. proper; 30, Autonomous Nakhichevan S. S. R.; 31, Autonomous Region of Karabagh. 32, Armenian S. S. R.

measure of self-government (2–22). The part of Soviet Russia that is divided into provinces is primarily the part inhabited by the Great Russian population, and the provinces represent administrative units by which the territory is directly administered by the Central Government at Moscow. There are forty-seven provinces, of which forty are classified as falling within European Russia and seven as falling within Asiatic Russia.[4] In addition to these forty-seven provinces there exists the so-called Far

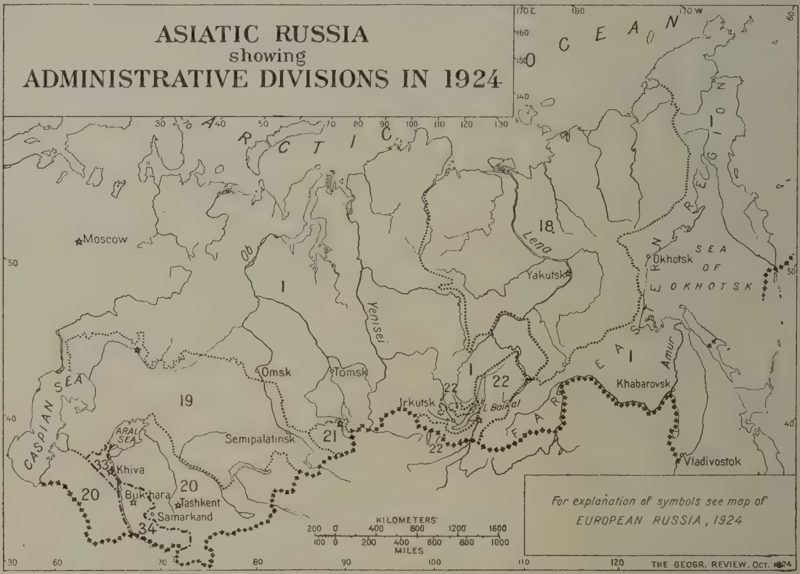

FIG. 2—Map of Asiatic Russia showing political subdivisions in 1924. 1, 18–22, Russian Socialist Federated Soviet Republic; 1, part of R. S. F. S. R. divided into provinces; 18–22 incl., autonomous republics and autonomous regions (*oblasti*) of the R. S. F. S. R. as follows: 18, Yakut Republic; 19, Kirghiz Republic; 20, Turkestan Republic; 21, Oirat Region; 22, Buryat-Mongol Republic. 33, Khivan People's Soviet Republic. 34, Bukharan People's Soviet Republic.

Eastern Region, which comprises most of the territory of the former Far Eastern Republic. This region at present is subdivided into four provinces, one of which, the Maritime Province, includes the northern part of the Island of Sakhalin, which is now occupied by the Japanese. The Far Eastern Region is an integral part of the Russian Soviet Republic. The association of the four provinces into a larger administrative union in this case does not represent the formation of a national unit but is rather due to the peculiar interests and special conditions existing in those areas formerly comprising the Far Eastern Republic.

The territories of the so-called Russian Soviet Republic that have certain

[4] European Russia is eventually to be reorganized into twelve "economic regions." Two of these are at present in process of creation—the Ural Region and the Southeast Region. The Ural Region includes the former Perm, Ekaterinburg, Chelyabinsk, and Tyumen provinces; the Southeast Region is to include the Don and Kuban regions, the Ter and Stavropol provinces, the city of Grozni, the Kabardino-Balkar, Karachaevo-Cherkess, Cherkess-Adighé, and Chechen autonomous regions, with capital at Rostov. [See *Geogr. Rev.*, Vol. 14, 1924, pp. 475–476.—EDIT.]

rights of self-government (2–22) fall into two groups, autonomous republics and autonomous regions. An autonomous region is simply an area inhabited by a certain nationality, organized out of one or several former provinces into a single unit with a provincial system of administration. It represents an attempt to bring people belonging to the same nationality into a single administrative unit that to all intents and purposes is similar to a "province," the term applied to the subdivisions of the area occupied by the Great Russian race. There are at present ten autonomous regions, all of which, except one, fall within the limits of European Russia.

Region (*Oblast*)	*Administrative Center*
Chuvash Region (6)	Cheboksari
Votyak Region (4)	Izhevsk
Kalmuck Region (11)	Ellista
Mari Region (5)	Krasnokokshaisk
Ziryan (Komi) Region (3)	Ust-Sisolsk
Kabardino-Balkar Region (15)	Nalchik
Karachaevo-Cherkess Region (16)	Batalpashinsk
Cherkess-Adighé Region (17)	Tokhtomukai
Chechen Region (13)	Grozni
Oirat Region (21)	Ulala

Each of these regions has one representative in the Soviet of Nationalities. The autonomous regions are administered by regional executive committees, elected by the Regional Congress of Soviets.

Nationalities more advanced in the eyes of the Soviet Power are organized into autonomous republics and enjoy a larger measure of self-government. There are at present eleven autonomous socialist soviet republics within the Russian Soviet Republic, of which seven are in European Russia and four in Asiatic Russia.

Republic	*Administrative Center*
Bashkir Republic (9)	Ufa
Tatar Republic (8)	Kazan
Daghestan Republic (12)	Buinaksk
Mountain (*Gorskaya*) Republic (14)	Vladikavkaz
Crimean Republic (7)	Simferopol
Karelian Republic (2)	Petrozavodsk
Republic of the Volga Germans (10)	Pokrovsk
Kirghiz Republic (19)	Orenburg
Turkestan Republic (20)	Tashkent
Yakut Republic (18)	Yakutsk
Buryat-Mongol Republic (22)	Verkneudinsk

Each of these republics has five representatives in the Soviet of Nationalities. The administration of the republics, according to the Constitution of the Russian Soviet Republic, consists of local Soviets, their congresses and executive committees, a Central Executive Committee, and a Soviet of People's Commissars.

White Russian Socialist Soviet Republic (24)

The second member of the Soviet Union, the White Russian Socialist Soviet Republic, comprises the six eastern districts of the former Minsk Province, eight districts of the former Vitebsk Province, six of the Homel Province, and one from the Smolensk Province. The population, of which over 75 per cent are White Russians, now numbers about 4,000,000. The capital is Minsk.

Ukrainian Socialist Soviet Republic (23)

The third member, the Ukrainian Socialist Soviet Republic, comprises the territories of the former Russian Empire in which the Ukrainians (Little Russians) predominate. The population of the Ukraine according to the census of 1920 is estimated at 26,000,000, of which 5,000,000 are urban. Of the country population 88 per cent are Ukrainian, while of the urban population only 34 per cent are Ukrainian, 29 per cent being Great Russian and 32 per cent Jews. The capital is Kharkov. The territory of the Ukrainian Republic is at present divided into nine provinces. In passing, it is important to notice that Bessarabia is still considered as a province of the Ukraine, although now occupied by the Rumanians.

Trans-Caucasian Socialist Federated Soviet Republic (25–32)

The fourth member of the Union is the Trans-Caucasian Socialist Federated Soviet Republic, which itself is a federation of three constituent republics established by a treaty signed on March 12, 1922, by the Socialist Soviet Republics of Azerbaijan, Armenia, and Georgia. A constitution of the Federated Republic was elaborated and confirmed by the First Trans-Caucasian Congress of Soviets on December 13, 1922. The organization of the federal government is modeled on that of Soviet Russia. The capital is Tiflis. The government of the Trans-Caucasian Socialist Federated Soviet Republic has not as yet been centralized to the same extent as that of Soviet Russia, and the constituent republics, Azerbaijan, Armenia, and Georgia, still retain a large measure of genuine independence.

The Azerbaijan Socialist Soviet Republic (29–31) includes the former Baku Province and a large part of the Elizavetpol Province and adjoining districts. Its population is approximately 2,000,000, 75 per cent of whom are Azerbaijan Turko-Tatars. The capital of the republic is Baku. It comprises two autonomous areas, which are represented by one delegate each in the Soviet of Nationalities, the Autonomous Nakhichevan Republic (30) and the Autonomous Region of Karabagh (31).

The Armenian Socialist Soviet Republic (32) includes portions of the former Erivan, Alexandropol, and Elizavetpol provinces. The population numbers 1,200,000 and is 95 per cent Armenian. The capital is Erivan.

The Georgian Socialist Soviet Republic (25–28) includes most of the former provinces of Tiflis and Kutais and has a population of about

2,400,000, of whom about 80 per cent are Georgians. The capital is Tiflis. It comprises three autonomous areas, each of which has one representative in the Soviet of Nationalities; the autonomous Abkhazian Socialist Soviet Republic (26), which comprises six districts of the former province of Sukhum, the autonomous Adzharian Socialist Soviet Republic (28), which comprises the former Batum Province, and the autonomous South Osetian Region (27), which comprises the mountain region northwest of Tiflis inhabited by the Osets.

Other Territories

In addition to the above areas, which form a constituent part of the Soviet Union, there are three other regions standing in very close relation to the Soviet régime although not forming an integral part of the Union of Soviet Republics. Two of these states, the Khivan People's Soviet Republic (33) and the Bukharan People's Soviet Republic (34), are bound to the Soviet Union by treaties of alliance. Khiva has a population of about 1,000,000, of which 50 per cent are Uzbegs, 30 per cent Turkomans, and 15 per cent Kirghiz. Bukhara is considerably larger, having a population of about 3,000,000, of whom 80 per cent are Uzbegs, 6–7 per cent Kirghiz, and 7–8 per cent Turkomans. Both these states have entered into a customs union with Soviet Russia and have agreed to grant concessions to foreign states and individuals only with the approval of the Russian Soviet Republic. The third state in this category is Mongolia, which concluded an agreement with the Russian Soviet Republic on November 5, 1921, whereby the Russian Soviet Republic recognized the People's Government of Mongolia as the only legal government. At present Urga, the seat of the Mongolian Government, and other strategic points are occupied by Soviet troops.

PRESENT STATUS OF INTERNATIONAL BOUNDARIES IN SOUTH AMERICA

By Raye R. Platt

The past quarter of a century has witnessed much progress in the definition and demarcation of the international boundary lines between the republics of South America as the geographical features have become better known. At the beginning of this century the boundary disputes of major importance involved seven great areas. Of these, three—the Venezuela-Colombia, the Peru-Bolivia, and the Argentine-Chile—have been settled. Of the four remaining, the Argentine-Bolivia dispute has been reduced to one of minor proportions; Colombia and Ecuador have arrived at an amicable settlement of their common share in the long-standing Peru-Ecuador-Colombia dispute; and the Chile-Peru dispute is at present in process of adjustment at Washington, the President of the United States acting as arbitrator. There remain still, without prospect of early settlement, only the Peru-Ecuador and the Bolivia-Paraguay disputes.

Many of the boundaries, however, are still undemarcated. Of approximately 15,000 miles of international boundary in South America about 8000 miles have been demarcated, while the disputed areas still involve nearly 2500 miles of boundary yet to be defined. Also many sections which may be considered as demarcated have been marked only with a few pillars in critical places, with the result that wherever in the future a frontier area between such pillars becomes sufficiently populated as to necessitate a precise location of the line the boundary question for such a section will of necessity be reopened. It follows, therefore, that a boundary can only be completely and finally settled when the area involved has been accurately triangulated and topographically surveyed and the results plotted on maps acceptable to all the parties concerned.

In the following notes boundaries whose land sections are demarcated and whose waterway boundaries are defined according to official surveys or surveys accepted as official are accepted as completely demarcated. However, such a designation has obvious limitations. With the greater commercial development of the South American realm it is certain that the problem of the sovereignty of natural resources which may underlie river channels will arise again and again.

Colombia-Panama

By the treaty of April 6, 1914, between Colombia and the United States, Colombia recognized Panama as an independent nation and agreed that the boundary between Colombia and Panama should be the boundary between

FIG. 1—Map showing the status of international boundaries in South America. Numbers have reference to areas in dispute thus: 1, Peru-Ecuador; 2, Peru-Colombia; 3, Colombia-Brazil; 4, Chile-Peru; 5 and 6, major disputed areas between Argentine Republic and Bolivia; 7, Bolivia-Paraguay. The scale of the map is 1 : 47,500,000.

the Colombian provinces of Cauca and Panama as defined by the Colombian Law of June 9, 1855.[1] Panama, however, was not a party to this treaty and had no diplomatic relations with Colombia until May 8, 1924, when at the invitation of the Secretary of State of the United States the ministers to the United States from Colombia and Panama met and signed an agreement which provided for a boundary convention and treaty of peace and friendship. Until such time as the decision of this convention is ratified by the two governments the boundary must be considered as undefined.

Colombia-Brazil

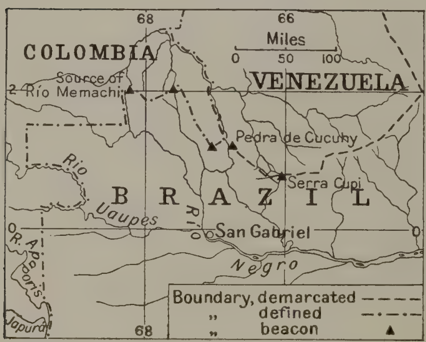

FIG. 2—Map showing Brazil-Colombia boundary defined by the Treaty of Bogotá, April 24, 1907. The boundary beacons are those set up by the joint Venezuela-Brazil commission in 1879 and 1880. Scale of map 1 : 12,000,000.

By the Treaty of Bogotá of April 24, 1907, the boundary between Colombia and Brazil from the mouth of the Rio Apaporis in the Rio Japurá or Caquetá to a point on the island of San José in the Rio Negro opposite Pedra de Cucuhy was defined.[2] Three monuments set up by the joint Venezuela-Brazil boundary commission in 1879 and 1880 mark the section of this line which lies between the source of the Rio Memachi and San José island. All of this section is now included in the Colombia-Brazil boundary, and since Colombia was not a party to the erection of these monuments the entire line must be taken as undemarcated.

From the mouth of the Rio Apaporis southward to the mouth of the Rio Ambiyacu in the Rio Amazonas, defined by the Treaty of Bogotá of July 15, 1916, as the easternmost limit of the boundary between Colombia and Ecuador, is an area divided, by the Tabatinga-Rio Apaporis line of the Brazil-Peru treaties of 1851 and 1874, into two disputed sections. The section west of the Tabatinga-Rio Apaporis line is still in dispute between Peru and Colombia. Colombia was not a party to the treaties which defined this line and disputes the claim of Brazil to the area between the Rio Japurá and the Rio Amazonas from the Tabatinga-Rio Apaporis line eastward to the confluence of the Japurá with the Amazonas.[3] By the Brazil-Ecuador boundary treaty of May 6, 1904, Ecuador agreed that in case the Peru-Ecuador boundary dispute was settled in favor of Ecuador the boundary between Ecuador and Brazil should follow the line agreed

[1] Informe del Ministerio de Relaciones Exteriores, Bogotá, 1914, p. 151.

[2] Thiers Fleming: Límites e superficie do Brazil e seus Estados, Rio de Janeiro, 1918, pp. 123 and 124. See also Demetrio Salamanca T.: La Amazonia Colombiana: Estudio geográfico, histórico y jurídico en defensa del derecho territorial de Colombia, Vol. 1, Bogotá, 1916, pp. 246–247.

[3] Salamanca T., *op. cit.*, pp. 479 and 854.

upon between Brazil and Peru by the Convention of Lima of October 23, 1851, and the modifications specified by the subsequent agreement signed between Brazil and Peru at Lima, February 11, 1874.[4] Ecuador is therefore no longer a party to any settlement of the boundary from the mouth of the Rio Apaporis to the Rio Ambiyacu which will follow the adjustment of the counter claims of Peru and Colombia in this region.

Colombia-Ecuador

By the Treaty of Bogotá of July 15, 1916, the boundary between Colombia and Ecuador from the mouth of the Rio Mataje in the Pacific Ocean to the mouth of the Rio Ambiyacu in the Amazon River was defined. As set forth by the concluding session of the joint boundary commission at Cartagena, July 9, 1919, the boundary from the mouth of the Rio Mataje to the most westerly point of the watershed between the Rio Putumayo and the Rio Napo was surveyed by precise triangulation and by measurements adjusted to points located astronomically by telegraphic time signals from Quito and was marked by monuments.[5] The joint commission found that at many points the definition of the boundary had been based upon inadequate knowledge of the topography. Important modifications were found necessary, and agreement in each case was arrived at by the commission. A gap on the Rio San Juan was not surveyed, there being apparently no doubt as to the position of the boundary in this section.

From the eastern end of the demarcated section the line is defined as following the divide between the Rio Putumayo and the Rio Napo to the source of the Rio Pastaza, which is considered as the principal head stream of the Rio Ambiyacu. Thence the line follows the Rio Pastaza and the Rio Ambiyacu to the Amazon. All of this section falls within the area claimed by Peru, and its final definition must await the settlement of the Peru-Ecuador dispute.

Colombia-Venezuela

By an arbitration agreement signed at Caracas, September 14, 1881, the long-standing boundary dispute between Colombia and Venezuela was referred to the Spanish Crown for settlement. At Paris, February 15, 1886, an act was signed by representatives of the two countries which repeated the agreement of 1881. On March 16, 1891, the Spanish Crown rendered its decision, and on July 6, 1891, the Colombian minister at Caracas suggested the appointment of a mixed commission to carry out the award of arbitration, inasmuch as part of the boundary as defined did not follow natural frontiers. After some delay a convention was signed in Caracas, December 30, 1898, establishing a mixed commission. Surveys were made of several sections of the boundary in 1900–1901, but, in view of many

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[4] *Ibid.*, p. 253.

[5] Arreglo de límites entre las Repúblicas del Ecuador y Colombia, documentos oficiales, Quito, 1920. See also *Geogr. Rev.*, Vol. 11, 1921, pp. 296 and 297.

important disagreements, a convention was signed at Bogotá, November 3, 1916, by which it was agreed to submit the execution of the Spanish award to the Swiss Federal Council.

On March 24, 1922, the Swiss Council presented its decision which provided for a committee of Swiss experts who should survey and examine those sections still in dispute and rectify positions located by the joint Venezuelan-Colombian commission in 1900 and 1901. The Swiss experts were to complete their mission by December 31, 1924. Meanwhile the two governments were instructed to occupy such areas as had been accepted by the mixed commission in 1900 and 1901.[6]

Venezuela-Brazil

The Treaty of Caracas of May 5, 1859, first defined the Venezuela-Brazil frontier. According to its provisions a mixed commission later surveyed this boundary from Pedra de Cucuhy to Serra Cupi, or Cupuy. In addition the commission surveyed the Rio Negro and its tributaries from the Pedra de Cucuhy to a monument erected at the principal source of the Rio Memachi; territory then claimed by Venezuela but since assigned to Colombia and forming an item in the Colombia-Brazil Treaty of 1907. The only precisely demarcated section of the line which now divides Venezuela and Brazil is a small section (10,675 meters) of the straight line from the Falls of the Maturacá Canal to the Serra Cupi. In 1882 and 1884 the remainder of the line was located and marked in a few critical places by a Brazilian commission. By the Accordo of 1900 the frontier was again defined, and in 1915 protocols were signed at Caracas accepting the line between Pedra de Cucuhy and Serra Cupi as located in 1880 and referring the remainder, which had been located by the Brazilian commission in 1882 and 1884, to a mixed commission for verification. February 29, 1912, another protocol was signed at Caracas; and, in accordance with its terms, in December, 1914, and January, 1915, Pedra de Cucuhy was located by astronomical observations, and four monuments were set up on the line between Pedra de Cucuhy and the Falls of Maturacá.[7]

Venezuela-British Guiana

The boundary between British Guiana and Venezuela was defined by an award of the International Arbitration Court at Paris in 1899.[8] Demarca-

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[6] Arbitrage entre la Colombie et le Vénézuéla: Sentence arbitrale du Conseil Fédéral Suisse sur diverses questions de limites pendantes entre la Colombie et le Vénézuéla, Berne, 24 Mars, 1922, Neuchatel, 1922. See also H. Case Wilcox: An Exploration of the Rio de Oro, Colombia-Venezuela, *Geogr. Rev.*, Vol. 11, 1921, pp. 372–383; reference on p. 372, footnote 2.

On July 10 of this year the American Geographical Society was informed by Dr. Alfredo Jahn of Caracas, Venezuela, that the commission of Swiss experts had completed its work and returned to Europe. With the exception of an area of about 150 square miles along the boundary in the vicinity of Cúcuta the Swiss commission did no surveying work but accepted the work of the mixed commission of 1900 and 1901.

[7] Fleming, *op. cit.*, pp. 135–136. See also Libro Amarillo de Venezuela, Vol. 1, pp. 164–165, Vol. 2, pp. 384–387, Caracas, 1915.

[8] Grover Cleveland: The Venezuelan Boundary Controversy, Princeton and London, 1913.

tion was completed in 1900 except for the section of the boundary between the summit of Mt. Roraima and Wenenau Creek. A deviation for this section of the boundary from the definition of the award was suggested by the joint commission and accepted by the two governments. The line of deviation follows the watersheds separating the Coroni, Cuyuni, and Mazaruni Rivers. In 1914 it was agreed that a joint commission should again demarcate the boundary with permanent monuments. This demarcation was carried out in 1916 and 1917.[9]

Brazil-British Guiana

By decision of the King of Italy, June 6, 1904, and by subsequent direct agreement between the two governments, the boundary between Brazil and British Guiana was defined. One monument has been set up at the source of the Rio Ireng or Mahu. No precise surveys have been made of the land sections of the line.[10]

British Guiana-Dutch Guiana

By the Treaty of Paris of 1814 the Dutch government ceded to Great Britain her colonies of Demarara, Berbice, and Essequibo. Discussion respecting the boundary line between these colonies and the present Dutch colony has to do with the question whether the head stream of the Courentyn River, which formed part of the eastern boundary of the ceded Dutch colonies, was the Cutari or the New River.[11]

Brazil-Dutch Guiana

The boundary between Brazil and Dutch Guiana is defined by treaty of May 5, 1906, as following the divide between streams flowing to the Amazon and those flowing to the Atlantic Ocean from the source of the Courentyn River to the source of the Maroni. The line has not been demarcated.[12]

Dutch Guiana-French Guiana

According to an agreement signed in 1836 the Maroni River was declared to be the boundary between Dutch and French Guiana. The joint commission appointed under this agreement was unable, however, to decide as to whether the Awa River or the Topanahoni was the main head stream of the Maroni. The matter was referred to the Emperor of Russia who, in 1891, rendered a decision accepting the Awa as the main head stream. In 1905 claims to certain disputed territory between the upper Maroni and the Iteng Rivers were settled by agreement between France and the

[9] Libro Amarillo de Venezuela, pp. 602–612, Caracas, 1915; pp. 328–336, Caracas, 1916; pp. 572–582, Caracas, 1917; pp. 211–212, Caracas, 1918.

[10] Fleming, *op. cit.*, p. 124.

[11] See H. D. Benjamins: De grenzen van Suriname, *West-Indische Gids*, 1921, Vol. 2, pp. 333–350.

[12] Fleming, *op. cit.*, p. 124.

Netherlands. The question of gold exploitation on the upper Maroni was solved by giving alternate reaches of the river to the French and Dutch, respectively. The principal islands of the lower Maroni were assigned to France at this time. Inasmuch as the whole river has been surveyed and the line in disputed areas demarcated, the entire boundary may be accepted as demarcated.

Brazil-French Guiana

A decision of the President of the Swiss Confederation, December 1, 1900, defined the boundary between Brazil and French Guiana. Inasmuch as no official survey of the Oyapock River, which forms the greater part of the boundary, has been made and no precise survey of the divide from the source of Maroni River to the source of the Oyapock exists, the entire boundary must be considered undemarcated.[13]

Brazil-Uruguay

The boundary treaties of 1851 and 1852 defined the boundary between Brazil and Uruguay, and, by the Accordo of 1853, the rights of the two nations in the Lagôa Mirim, the Rio Jaguarão, and the Arroyo San Miguel were determined. In 1852 and 1859 a part of the boundary from the mouth of the Arroyo Chuy in the Atlantic Ocean to the town of Quarahy on the Rio Quarahy was surveyed and 162 monuments erected.[14] Since official surveys exist for the Rio Quarahy the entire line may be considered demarcated.

By the Boundary Treaty of 1909 Brazil and Uruguay determined to resurvey the boundary, and between 1909 and 1912 the two commissions that had been appointed completed the triangulation of a section from the southern point of Lagôa Mirim to the source of the Rio Jaguarão.[15]

Brazil-Argentine Republic

The frontiers of Brazil and the Argentine Republic were first defined by treaty in 1857. In February, 1895, the section between the Rio Uruguay and the Rio Iguassú was again defined by the award of the President of the United States.[16] Difficulties in the interpretation of this award were adjusted by the Treaty of September 6, 1898. Between November, 1900, and October, 1904, the entire frontier was demarcated by a mixed commission except for a short section of the Rio Quarahy near the island of Quarahy or Brazileira. An act of October 4, 1910, signed at Rio de Janeiro,

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[13] Fleming, *op. cit.*, p. 125.

[14] *Ibid.*, pp. 127 and 128.

[15] See Rapport sur les travaux géodésiques éxécutés de 1912 à 1922 par le Service Géographique de l'Armée Uruguayane, Colonel P. Gros, Toulouse, 1923; and Notice sur quelques travaux géodésiques éxécutés par des officers de l'Armée Brésilienne, Rio de Janeiro, 1922.

[16] J. B. Moore: History and Digest of the International Arbitrations to Which the United States Has Been a Party, 6 vols., Washington, D. C., 1898; reference in Vol. 2, pp. 1969–2026.

assigned certain islands in the Rio Uruguay and the Rio Iguassú to Brazil and the Argentine Republic, respectively.[17]

Brazil-Paraguay

By treaty of January 9, 1872, and the protocol of January 7, 1874, the boundary between Brazil and Paraguay was defined. The demarcation of the line was completed between August, 1872, and October, 1874, except for a section between the mouth of the Rio Apa and the mouth of the river known as Bahia Negra. Final definition of this section must await the

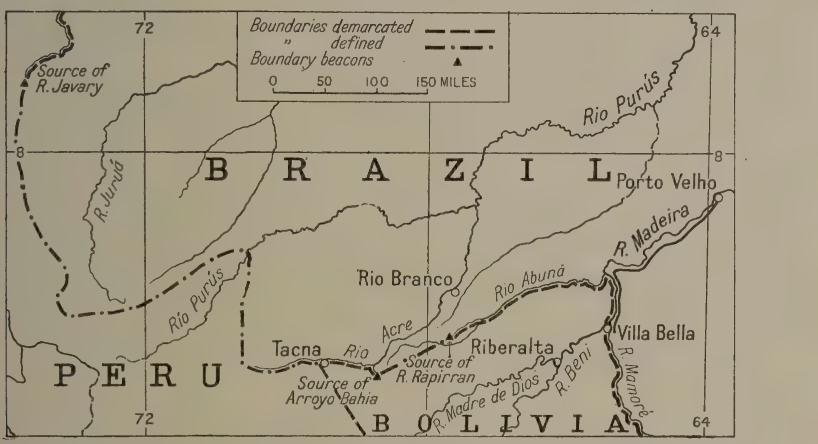

FIG. 3—Map showing the Peru-Brazil boundary defined by the Velarde-Rio Branco Treaty, July 12, 1904, and the Madeira-Acre section of the Brazil-Bolivia boundary defined by the Treaty of Petropolis, February 6, 1907. Scale of map 1 : 12,000,000.

settlement of the dispute between Paraguay and Bolivia. In the Rio Paraguay all reaches of the river to the north and east were assigned to Brazil, and those to west and south to Paraguay. The island of Fecho dos Morros was given to Brazil.[18]

Brazil-Bolivia

A treaty signed in 1867 defined the boundary between Brazil and Bolivia, and a joint commission immediately set to work to demarcate the entire boundary. In 1871 and from 1875 to 1878 two joint commissions and a Brazilian commission completed the demarcation of the section from the mouth of the Bahia Negra to the confluence of the Mamoré and Beni Rivers. Peru protested against the definition of the line from the confluence of the Mamoré and Beni Rivers to the source of the Rio Javary on the ground that this section of the line as defined ran through territory to which Peru laid claim. Final agreement was not arrived at until the final

[17] La Frontera Argentina-Brasileña (Estudios y Demarcación General 1887–1904, Division de Límites Internacionales, Vol. 1), Buenos Aires, 1910, pp. 544–561.

[18] *Ibid.*, pp. 129 and 130.

demarcation of the Peru-Bolivia boundary in 1911–1913. In 1897 a Brazilian commission marked the source of the Rio Javary and located it by astronomical observations. In 1899 a joint commission was appointed to mark the Madeira-Javary frontier. Again in 1901 and 1902 a joint commission undertook to verify the location of the source of the Rio Javary but was stopped by the revolution in Acre.[19]

The line was defined anew by the Treaty of Petropolis of November 17, 1903, in which special emphasis was given to the definition of that section of the boundary between the Rio Madeira and the Peru-Bolivia boundary.[20] An agreement of February 6, 1907, provided for a joint commission to mark the frontier established by the Treaty of Petropolis, to explore the section between the monument known as Marco Quatro Irmãos and a monument located on the right bank of the Rio Turvo in 1875, and to explore the Rio Verde. All of this work was carried out with exception of (1) the section between the Rio Turvo and the source of the Rio Verde and (2) a section between the principal source of the Rio Rapirran (a tributary of the Abuná) and the source of the Arroyo Bahia (a tributary of the Acre). With the exception of the latter section the frontier from the Madeira to the Peruvian-Bolivian boundary was surveyed with considerable exactness. A large number of points were located by astronomical observations, and a great many heights were measured.[21]

Brazil-Peru

By treaty of October 23, 1851, it was agreed between Brazil and Peru that their common boundary from the hamlet of Tabatinga on the Amazon River northward should be by a direct line to the Rio Japurá, or Caquetá, opposite the mouth of the Rio Apaporis and southward from Tabatinga by the Rio Javary from its confluence with the Amazon River.[22] Joint commissions working in 1866, 1873, and 1877 demarcated this boundary from the source of the Rio Javary to the mouth of the Rio Apaporis and agreed to a slight modification of the line whereby it should for a short distance follow the channel of the Rio Iça. By treaty of May 6, 1904, Ecuador agreed to recognize as her common boundary with Brazil such part of the line established between Brazil and Peru by the treaty of 1851 as would fall to Ecuador in case the Peru-Ecuador dispute should be settled in Ecuador's favor. When in 1867 Brazil and Bolivia agreed as to the location of their common boundary Peru protested on the ground that the line as defined from the confluence of the Rio Beni and the Rio Mamoré to the source of the Rio Javary ran through a region in which Peru disputed both Bolivian and Brazilian claims. The subject was the matter of frequent

[19] *Ibid.*, pp. 131–132.

[20] Memorandum del Ministerio de Relaciones Exteriores, Lima, 1903, p. 28.

[21] Fleming, *op. cit.*, p. 134.

See also P. H. Fawcett: Survey Work on the Frontier between Bolivia and Brazil, *Geogr. Journ.*, Vol. 33, 1909, pp. 181–185; and Memoria de Relaciones Exteriores de Bolivia, La Paz, 1916, p. 13.

[22] J. B. Moore: Brazil and Peru Boundary Question, New York [1904], p. 19.

discussion until an agreement was signed July 12, 1904, whereby two areas in the upper Juruá and Purús Rivers were declared neutral zones pending a definitive settlement of the line. By the Velarde-Rio Branco Treaty of September 8, 1909, a final settlement was reached by which the line was located from the Peru-Bolivia boundary on the Rio Acre, still in dispute, to the source of the Rio Javary; Peru agreeing in her negotiations with Bolivia to recognize the accord reached by Brazil and Bolivia in the Treaty of Petropolis as to the Brazil-Bolivia boundary along the Acre.[23]

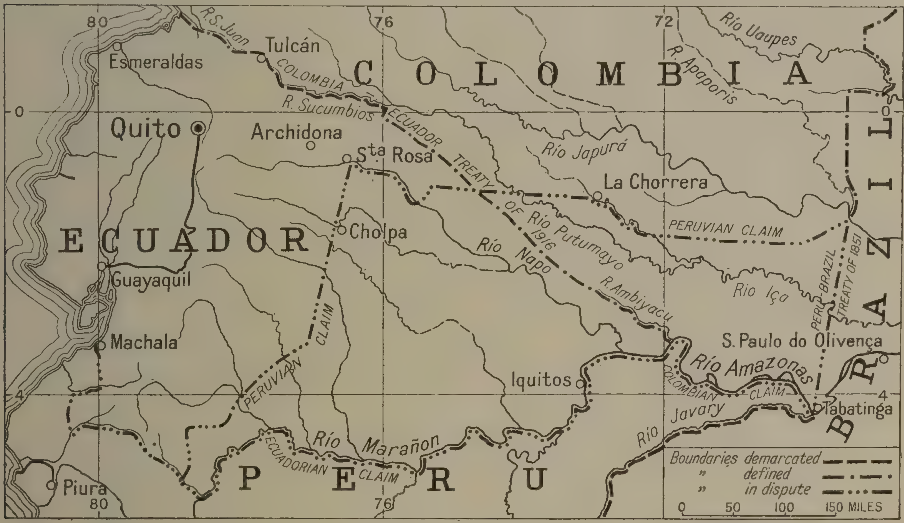

FIG. 4—Map showing the areas in dispute between Peru and Ecuador and Peru and Colombia, with the boundaries of the respective claims and the Colombia-Ecuador boundary defined by the Treaty of Bogotá, July 15, 1916. Scale of map 1 : 12,000,000.

Brazil-Ecuador

As mentioned above, a boundary treaty signed May 6, 1904, between Brazil and Ecuador agrees on the part of Ecuador that in case the dispute between Ecuador and Peru is decided in Ecuador's favor the boundary between Ecuador and Brazil shall be as established by the Convention of Lima of October 23, 1851, between Brazil and Peru and the modifications specified in the subsequent agreement signed between Brazil and Peru at Lima, February 11, 1874.[24] In case, therefore, Ecuador does win her claim and secure territory bounded by Brazil, her frontiers with Brazil will have been already defined and demarcated.

[23] In 1921 the American Geographical Society was notified by the Peruvian Embassy at Washington that a joint commission was engaged in surveying and demarcating the line from the Peru-Bolivia boundary demarcated in 1911–1913 to the source of the Rio Javary. A collection of unpublished maps received by the Society from the Lima Geographical Society since January, 1924, contains maps of surveys made by this joint commission in the upper Juruá and Purús. It is believed, however, that the work has not yet been completed.

[24] Salamanca T., *op. cit.*, Vol. 1, p. 243.

Ecuador-Peru

The Peruvian-Ecuadorean boundary dispute is one of the two disputes of major importance still to be settled in South America. It dates from the secession of the Republic of Ecuador from the triple confederation of Colombia, August 14, 1830. Ecuador claims that she is the heir of Colombia to the boundary between Colombia and Peru as defined by the Treaty of Guayaquil of September 22, 1829, and modified by the Pedemonte-Mosquera Protocol of 1830. Peru refuses to recognize this heirship, at least as far as the boundary is concerned, and claims a great region in the Oriente extending across territory claimed by Ecuador and into territory claimed by Colombia to a point in the Rio Japurá at the mouth of the Rio Apaporis.

Numerous treaties have been executed, but all have failed of ratification. Ecuador insists that arbitration or mediation of any sort is unnecessary since she stands ready to accept to the letter the Treaty of Guayaquil of 1829 and the Pedemonte-Mosquera Protocol of 1830. It was agreed, however, on August 1, 1887, by the Espinosa-Bonifaz Treaty to submit the question to the King of Spain. Ecuador, on learning that the decision of the King of Spain was to be in favor of Peru, withdrew from the arbitration. In the strained relations that followed, Brazil, the Argentine Republic, the United States, and the Hague Tribunal offered their services as mediators. Ecuador refused all offers on the ground that in the Treaty of 1829 lay the means for a settlement without outside help.[25] In 1911 the two governments agreed to make no further attacks on settlements established by the two countries in the Oriente pending a definite settlement of their counterclaims.

Peru-Chile

The history of the boundary controversy between Peru and Chile is too well known to require detailed description here. According to the Treaty of Ancón of October 20, 1883, Chile was to hold Tacna and Arica for ten years, at the end of which time a plebiscite was to be held to determine by vote the future sovereignty of the province. At the expiration of the first ten years and subsequently Chile progressively delayed the holding of the plebiscite. A protocol and supplementary act was signed at Washington, July 20, 1922, and ratified January 15, 1923, which provided for the submission by each country of its claims and supporting evidence to the President of the United States as mediator. On November 13, 1923, these claims and evidence were presented by both countries. According to latest information a two-months' extension of time was granted on April 13, 1924, for the submission of further evidence on application by the Chilean representatives and agreement by the Peruvian representatives.

[25] Pastoriza Flores: History of the Boundary Dispute between Ecuador and Peru, New York, 1921. See also *Geogr. Rev.*, Vol. 5, 1918, p. 327.

Peru-Bolivia

Officially, the boundary controversy between Peru and Bolivia begins with the recognition of the Republic of Bolivia by the Republic of Peru, May 18, 1826. The first boundary treaty signed by representatives of the two countries was the Treaty of Chuquisaca, November 15, 1826, by which Bolivia was to cede to Peru all her claims of sovereignty in Lake Titicaca, while maintaining to herself equal rights with Peru of navigation and fishing in the lake. In return Bolivia was to secure an addition to her littoral province from the eighteenth to the twenty-first parallel of latitude. The treaty proved unsatisfactory to both parties, and a second treaty was signed at Arequipa, November 8, 1831, which provided for a joint commission to make a map of the frontier regions in order that the changes and concessions necessary might be made with a minimum of detriment to the countries concerned. Bolivia rejected this treaty, and a third convention was signed at Cuzco on August 14, 1839, by which it was agreed to demarcate the boundary along natural barriers and to accept the Rio Desaguadero as a part of this natural boundary. Bolivia again objected not only because of the loss of certain provinces west of the Rio Desaguadero but also because the Rio Desaguadero was not considered a sufficiently strong international barrier.

Again in 1896 negotiations were opened at Sucre, and on July 21, 1897, it was agreed to give 60 days to the study of the problem and, in case of failure in arriving at an agreement, to submit the entire question to the Spanish Crown for arbitration. At the conference a suggested *modus vivendi* was presented, but no agreement was reached. Shortly afterward, in 1898, representatives met at Lima and agreed to appoint a joint commission to survey the frontier region, to study the line across Lake Titicaca, and to present a proposal for the settlement of all or part of the line. Six months were to be allotted to the work, and at the end of that time the Spanish Crown was to be asked to settle the question, basing its study on the location of the line of 1810 between the *audiencias* of Lima and Charcas. A revolution in Bolivia put an end to these negotiations.

By a treaty of arbitration, December 30, 1902, the Argentine Government was asked to study evidence submitted and decide the location of the ancient boundary between the *audiencias* of Lima and Charcas. By Article 2 of this treaty it was stated that the section of the boundary running from the line between the provinces of Tacna and Arica and the Bolivian province of Carangas to the Nevados de Palomani north of Lake Titicaca had already been defined and its demarcation provided for by a treaty of September 23, 1902. The Argentine Government, therefore, was to limit its work to the section north of the Nevados de Palomani.

The award was presented July 9, 1909. Bolivia objected to many details of the decision. Peru recognized the justice of many of these objections, and as a result a treaty was negotiated by direct accord September

17, 1909, by which the difficulties were adjusted to Bolivia's satisfaction. On February 2, 1911, both countries appointed boundary commissions, and in 1911–1913 the line from the mouth of the Arroyo Pachacili in the Rio Suches to the Rio Acre was surveyed and demarcated except for a section from the southerly end of the Cordillera de Ichocorpa between the Lanza and Tambopata Rivers to the confluence of the Rio Heath and the Rio Madre de Dios—a section surveyed by the Peruvian commission but left undemarcated because of the difficulties of the task.[26]

The section from the Rio Suches to the Chilean frontier still remains undemarcated.

Bolivia-Chile

At the close of the war of 1879–1883 Bolivia lost her littoral province of Antofagasta and all access to the Pacific Ocean except such as Chile would permit. The years from 1883 to 1904 saw many negotiations and treaties, none of which were effective until that of October 20, 1904, by which Bolivia definitely ceded to Chile her coastal territory and was granted an outlet to the sea by way of the Arica-La Paz railroad since constructed. The survey of the boundary was completed and the boundary demarcated and maps published in 1912. Bolivia, however, may still open the question again at any time in view of her contention that the treaty was forced upon her.[27]

Bolivia-Paraguay

The first of the important boundary treaties executed between Paraguay and Bolivia was that of October 15, 1879, which defined the northern limits of Paraguay in the Gran Chaco as the parallel of the mouth of the Rio Apa in the Rio Paraguay from the mouth of the Rio Apa to the point where that parallel cuts the Rio Pilcomayo. This treaty proved unsatisfactory to Paraguay whose claims extended as far north as to include the Bahia Negra.

A new treaty, the Treaty of Tamayo-Aceval of February 16, 1887, divided the disputed territory into three sections and recognized as belonging to Paraguay the section between the Rio Pilcomayo and the parallel of the mouth of the Rio Apa as far west as the sixty-third meridian from Greenwich. The second section, between the parallel of the mouth of the Rio Apa and the parallel which cuts the Rio Paraguay one Spanish league north of Fuerte Olimpo and extending as far west as the sixty-third meridian from Greenwich, was to be the subject of further negotiation. The third section, between the second section and the Bahia Negra, was to be given to Bolivia. This treaty expired unratified. On November 23, 1894, a new treaty was arranged which defined the boundary as a straight line from a

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[26] Miguel Mercado M.: Historia internacional de Bolivia: Cuestiones de límites, Cochabamba, 1915, pp. 281–326.

See also Peru-Bolivia Boundary Commission, 1911–1913: Reports of the British Officers of the Peruvian Commission, Diplomatic Memoranda and Maps of the Boundary Zone, Cambridge, 1918.

[27] José Carrasco: Bolivia's Case for the League of Nations, London, 1920.

See also: Mercado M., *op. cit.*, pp. 191–280.

point three Spanish leagues north of Fuerte Olimpo to the principal course of the Rio Pilcomayo at 61° 28′ west of Greenwich. This treaty because it was considered "detrimental to the interests of Bolivia" was never submitted to the Bolivian Congress.[28]

In 1913 it was agreed between the two countries that all previously written agreements would be annulled and that an attempt would be made to settle the matter by direct negotiation. In case this failed recourse was to be had to arbitration.

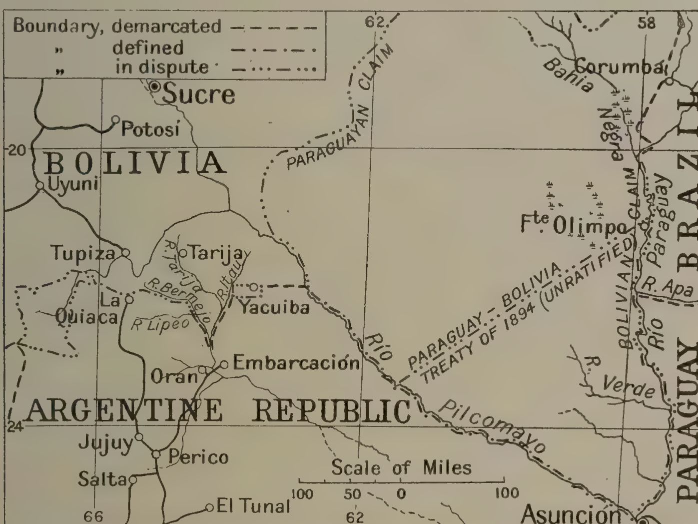

FIG. 5—Map showing areas in dispute (1) between Bolivia and Paraguay and (2) between Bolivia and the Argentine Republic (Yacuiba and overlapping claims west of La Quiaca). Scale of map 1 : 12,000,000.

Bolivia-Argentine Republic

The first of the important treaties leading to a final settlement of boundary dispute between Bolivia and the Argentine Republic was the Treaty of Friendship, Commerce, and Navigation signed at Oruro, December 7, 1859. Bolivia did not ratify this treaty, and four more treaties or protocols were drawn up and rejected before the treaty of May 10, 1889, definitely located the boundary from the extreme northern limit of the Chile-Argentine boundary to the point where the twenty-second parallel cuts the Rio Pilcomayo. This treaty, by which Bolivia lost her claims in the Puna de Atacama and the Chaco Central but gained her claims in the province of Tarija, was ratified by the Argentine Republic November 12, 1891, and by Bolivia September 15, 1892.[29]

Commissions appointed to survey the boundary found that in a great many details the definition of the boundary had been based on inadequate

[28] Luis de Gásperi: Geografía del Paraguay, Buenos Aires, 1920, pp. 244–248. See also Mercado M., *op. cit.*, pp. 71–134.

[29] Mercado M., *op. cit.*, pp. 135–190.

or completely erroneous ideas of the topography of the region involved. For instance, in 1895 it was found that the Bolivian town of Yacuiba lay south of the twenty-second parallel in territory assigned to the Argentine Republic by the treaty. With a view to correcting errors in the original definition of the line, "rectifying protocols" were signed in 1898, 1902, and 1904, and the General Treaty of Arbitration on January 27, 1903. In 1909 a rupture in the diplomatic relations between Bolivia and the Argentine Republic took place as a result of the Argentine award in the Peru-Bolivia boundary dispute. Relations were renewed, however, in 1911, and the treaty of 1889 was again recognized and approved. On October 13, 1911, a protocol was signed and approved assigning Yacuiba as well as the towns of Esmoraca, Rosario, San Juan, San Antonio, and Guadalupe and the mountains of Moroco, Bonete, Azulejo, and San Antonio to the Argentine Republic.

In spite of the terms of the protocol Bolivia still insists that she has been the victim of an erroneous conception of the topography and the location of towns in the area between the Chilean frontier and the Rio Pilcomayo, and the Argentine Republic has made no arbitrary demand that the protocol of 1911 be carried out to the letter. Bolivia still maintains a customhouse at Yacuiba and has offered territory elsewhere in exchange. The Argentine Republic, on the other hand, has offered Bolivia territory on the west bank of the Rio Itau in exchange for Yacuiba.[30] At any rate both countries are anxious to settle the difficulty. Meanwhile, although the entire boundary has been demarcated, the monuments are considered as provisional only. The entire boundary, therefore, must still be taken as in dispute, except for the section along the Rio Pilcomayo to the twenty-second parallel and along this parallel to the crest of the Sierra de Ipaguazu, and the section from the confluence of Rio Tarija and the Rio Itau to the confluence of the Rio Lipeo and the Rio Bermejo.

Paraguay-Argentine Republic

The Boundary Treaty of February 3, 1876, defined the boundary between Paraguay and the Argentine Republic as following the principal channel of the Rio Paraná from the Brazilian-Argentine boundary to its confluence with the Rio Paraguay and thence by the main channel of the Paraguay to its confluence with the main channel of the Rio Pilcomayo. The region between the Rio Pilcomayo and the Bahia Negra was divided into two sections. Of these the northern, between the Rio Verde to the Bahia Negra, was recognized as belonging to Paraguay. The southern, between the Rio Verde and the Rio Pilcomayo, was to be the subject of further negotiations. By award of the President of the United States, November 12, 1878, the southern section was also given to Paraguay, and the Rio Pilcomayo was declared the boundary as far as the Bolivian fron-

[30] See La cuestion de límites pendiente con la Republic Argentina, Ministerio de Relaciones Exteriores, La Paz, 1922.

tier.[31] Although official surveys of the Rio Paraná and Rio Paraguay exist, as well as accepted surveys of the Rio Pilcomayo, the line cannot be considered completely demarcated until the boundary between Bolivia and Paraguay is defined and located.

Argentine Republic-Uruguay

Brazil and the United Provinces of the Rio de la Plata recognized the independence of Uruguay by the treaty of August 27, 1828, in which Great Britain acted as mediator.[32] The boundary between Uruguay and the Argentine Republic was defined as following the natural channel of the Rio Uruguay to its mouth in the Rio de la Plata and thence the northeastern bank of the Rio de la Plata. Uruguay now claims the median line of the La Plata as the boundary. Her claim includes control of the channel built and lighted by the Argentine Republic.[33] The two governments signed a convention April 11, 1918, providing for a triangulation of the Rio Uruguay and the estuary of the La Plata from the mouth of the Rio Cuareim to the mouth of the estuary. To date this triangulation has not been carried out, but the Military Geographical Institutes of the two countries have been designated to do the work.

Argentine Republic-Chile

The treaty of 1856 was the first important treaty having to do with the defining of the Chilean-Argentine boundary. This treaty proved unsatisfactory, and a new treaty was signed July 23, 1881. The northern part of the boundary, especially in the Puna de Atacama, still lacked precise definition. The discussion reached its height in 1892; and in March, 1893, representatives were appointed to a convention which on May 1, 1893, signed a "Protocol adicional y aclaratorio del Tratado de Límites de 1881." Chile once more protested against the definition of the northern part of the boundary as set forth in this protocol, and a second protocol was signed in September, 1895, which, however, did not settle the question. By the Compromise of April 17, 1896, the two countries agreed to ask the mediation of the Queen of England if direct agreement could not be reached. In 1896 the two countries seemed on the verge of war, but delegates were again appointed and the act of September 22, 1898, was signed. Other acts and notes followed, and in March, 1901, delegates were appointed to a tribunal of arbitration. In May, 1902, a general treaty of arbitration was signed and, in July, 1902, a supplementary act by which it was agreed to submit the whole dispute to the King of England for arbitration. Experts were appointed who studied the problem on the ground and drew up proto-

[31] Moore: History and Digest, Vol. 2, pp. 1923–1944.
[32] W. S. Robertson: Rise of the Spanish-American Republics, New York, 1918, p. 180.
[33] See the map (Fig. 280, p. 578) in Isaiah Bowman: The New World, Yonkers, 1921.

cols and acts defining the boundary in the disputed sections. The King of England rendered his award November 20, 1902. Boundary commissions were appointed to survey the debated sections of the line and set up pillars. The work of demarcation was completed in 1907.[34]

[34] La Frontera Argentino-Chilena (Documentos de la Demarcación, Oficina de Límites Internacionales, Vol. 2), Buenos Aires, 1908.

GEOGRAPHICAL RECORD

NORTH AMERICA

A Texan Study in Range Economics. "An Economic Study of a Typical Ranching Area on the Edwards Plateau of Texas" by Professor Youngblood (*Texas Agric. Exper. Sta. Bull. No. 297*, College Station, Brazos Co., Tex., 1922) is an important contribution to the study of land utilization that must form the basis of an adequate land policy. The broad objects of the study are to correct the impression that ranching is an "exploitive industry and that it is destined to pass away, and in part to aid in placing the grazing industry on a sound economic and social basis." Such a study is important to millions of people and affects a large part of the national domain. It has been estimated that there are in the United States 615,000,000 acres of permanent range land, or about 32.4 per cent of the total area. When there are added to this area parts of woodland and forest that are suitable for grazing, the percentage is raised to 45. In individual states in the West the matter is of still more importance. Of the total area of Texas 73.4 per cent is devoted to grazing, and only 18.6 per cent is classified as improved land and farms. Professor Youngblood's study advances the education of the public respecting the land requirements of successful ranching. The industry is peculiarly susceptible to the menace of too small units. Area of land alone has no significance in ranching. A distinction must be made between farm land and ranch land and the different grades of each. In the better farming area of Texas there are required from 80 to 160 acres to make a "family-sized farm." In the permanent ranching country there are required from 2560 to 12,800 acres to support one family.

Professor Youngblood has done a useful service in making his study realistic throughout. By confining the detailed field work to a single county (Sutton) we obtain a concrete picture of the industry and its difficulties. Especially interesting is the plan (p. 132) of Halbert's ranch showing subdivisions into fields, location of dirt tanks and rock tank, the disposition of sheds, roadways, corrals, troughs for salt or water, and the like. In all, 97 ranches were studied and many interesting statistics are given of the value of land, stock, headquarters buildings, and particular economic and engineering difficulties; for example, the water system, with its surface reservoirs, its deep wells, and pumping engines. On the economic side the matter of labor supply, the sale of the products, marketing conditions, and diversity of products are all brought into the discussion. The study is full of well-classified geographical material that will be especially valuable when a broader synthesis is undertaken of the western ranching country as a whole.

A Source of Data for Regional Survey: An Example from Texas. The colonization of the earth by man is along the line of least geographic resistance, but, as the process goes on, the resistance increases until a point is reached where it becomes necessary to remove opposition by artificial means. Today, in most countries, the white race within the pioneer belt is engaged in occupying the less suitable places by interference with nature. If a place shows itself desirable difficulties are overcome. But even in the process of removal deference is shown to the accidents of nature, and only the easiest adaptations are effected. Many attempts fail, and struggling little places give up the ghost and are deserted. The country accepts the settler or drives him away; the minor features of geography are determinants of the prosperity of communities.

The geographer looks to the regional survey movement for the best development of his line of inquiry. Regional survey, overlooking nothing, inevitably becomes intensely local. The broad view can show only the outstanding condition. The intimate view is necessary to reveal the cause of the condition. Final realization must come from an appreciation of local circumstances, which, in turn, must be gathered by the survey from the local resident. Hence the local contribution to the geographic understanding of places becomes a factor of the greatest importance. Meanwhile valuable material is being produced; but much of it must pass unseen by those who would discern its wider value, and it is forgotten.

An example has come to hand which we produce in the hope of encouraging perhaps a few interested persons to collect material of the kind. It is a newspaper article (Louella Sewell Cullom: Scyene, *The Texas Mesquiter*, Friday, April 18, 1924) dealing, unconsciously to the point, with the history of a small Texan village ten miles east of Dallas. The village of Scyene, in the early days, seems to have been one of those more or less evenly distributed small centers that focus the minor external economics of a region of scattered population. Dallas was another and no more, it seems, than an equal. Both villages had the customary delusions of ultimate greatness. But Dallas had its navigable river, whereas Scyene, being situated on black, waxy land, had only wretched roads and was quite inaccessible in rainy weather. The position was one that demanded a large town sooner or later. In 1868 ferryboats came up from Houston to Dallas, consequently Dallas now has something akin to greatness, while Scyene has only delusions. But it keeps them. It hoped for the salvation of the railroad; but, owing to the chance matter of a right of way, the Texas and Pacific line avoided the place by a mile in 1871, and Scyene dwindled. But the old stage road from Dallas to Kaufman ran through Scyene; and the village remembers, for automobiles are here. They require roads, and roads defer to geography. Scyene has recently found itself on a main road, State Highway No. 15, and anticipates growth. The ultimate fate of the village will probably be incorporation with Dallas after a thriving satellitic phase. Among other picturesque things Mrs. Cullom relates the origin of the name, and place names are always of interest to geography. The early residents picked a good name, Seine, that of the French river, and misspelt it. A younger generation, hopeful for the place, changed the form to a more high-sounding one.

It may be noted here that the magazine section of the Sunday issues of the *Dallas News* contains a page or so devoted to the origins of Texan place names.

This contribution is typical of the more intelligent rural press in many parts of the country. We suggest that the geography teachers in local schools have an opportunity to collect and file material of this kind. It is directly applicable to teaching if the course given have any vitality. A few good examples of this kind of local study are enough to illuminate a whole region. The school record of local history and geography has, if it were only realized, an enviable opportunity of giving valuable aid to the regional survey which must come sooner or later if American geography is to keep pace with the world.

Sonora Storms. As explained by Dean Blake (*Monthly Weather Rev.*, Vol. 51, 1923, pp. 585–588), Sonora storms are those that bring the famous cloud-bursts on the west wall of the California desert. These storms were named when it was thought they originated in Sonora, Mex. Now, however, it is known that they develop in California, near where they run their course and end. When Sonoras are in progress their turbulent thunderheads may be seen from the coast, towering majestically above the mountains. The wind aloft flows seaward.

A western position of the desert low pressure area favorable to a large inflow and superheating of moist air from the Gulf of California occurs, on the average, but

one day a year, usually in July or August. On such a day from two to seven, sometimes even more than eleven, inches of rain may fall in one sudden downpour on the valleys and slope over 2000 feet above sea level. Where rain does not reach the ground numerous fires may be set by lightning. The waters roar down the dry gullies and wash away highways, railroads, or any other obstructions in their path. The extraordinarily violent character of these thunderstorm rains is owing to a great abundance of moist air heated to desert temperatures on a generally quiet day. On rare occasions, similar cloud-bursts occur on some western slopes of the Appalachians.

Charles F. Brooks

Per Capita Wealth in the United States. If the value of all property in a given region could be ascertained, and divided by the number of inhabitants, the resulting per capita wealth ought to be one of the best possible measures of standards of living. But there are great difficulties in the way of making accurate estimates of property values. Officials of every state, county, and city receive annual returns of the value of taxable property in their jurisdictions; but some valuable property, such as churches, schools, libraries, city and county buildings, parks and roads, is not taxed at all, some is overlooked, and in many communities property is assessed for taxing purposes far below its real value. (Some of the difficulties were discussed in the third volume of the Compendium of the 11th U. S. Census, 1897, pp. 943–948.)

Estimates of the true wealth of every state (and sometimes of every county) were made by the United States Census Office at each census from 1850 to 1900 (the first three times considering taxable property only) and again in 1904, 1912, and 1922. The results for December 31, 1922, have been published by the Department of Commerce in a series of mimeographed press bulletins of one page each, one for each state, at frequent intervals from December, 1923, to March, 1924; and the whole series was summed up in a four-page printed quarto leaflet issued the latter part of April, 1924, which gives comparative statistics all the way back to 1850.

As measured in dollars the estimated total wealth of the United States increased from about 186 billion in 1912 to 321 billion in 1922, or 72.2 per cent; and the per capita wealth increased from $1950 to $2918, or 49.6 per cent. But the constant fluctuations in the value of the dollar, especially during the World War, must be taken into consideration. Economists agree that average commodity prices in the United States were about 56 per cent higher in December, 1922, than in 1912; so that, instead of being 49.6 per cent richer than we were ten years before, we were really a little poorer. With this in mind we may ask how different states or other communities compare in per capita wealth and in rate of increase thereof. We learn that the estimated per capita wealth in different states at the end of 1922 ranged from $1216 in Mississippi and $1244 in Alabama to $4482 in South Dakota and $6998 in Nevada. It may be noted that in proportion of income tax payers and magazine readers, value of property per farm, and various other matters, the several states had approximately the same rank as in wealth.

But the states with an average per capita wealth below $2000 all have a large proportion of negroes, and if separate figures for different races were available the Southern whites might not rank much below those of the North and West. In 1920 the average white farmer in South Carolina or Florida was about on a par with those in Vermont and New Hampshire. The census does not separate the races in this inquiry, as it does in value of farm property, but the tax assessors of most southern states do.

One method of testing the accuracy of these estimates of wealth is to compare the value of all property per family with that of farm property per farm; for in

most states farm property is more valuable than all other real estate combined, and the average farm is a one-family institution. The number of families and of farms, together with the value of farm property, in any state or county on January 1, 1920, is easily ascertained from the census; and, although the wealth estimates were made three years later, we probably shall not be far wrong if we assume that the increase in real wealth during that period was just about counterbalanced by the decline of prices.

On this assumption the total wealth per family in the United States in 1920 was $13,100, as compared with $12,084 for the value of property per farm. If we eliminate non-taxable, or public, property (in which the farmer of course owns his share), the wealth per family would be about $12,250. This shows that the average farm family in this country is nearly as prosperous as the average city family—which may be contrary to prevailing impressions. On a per capita basis, to be sure, there would be a greater difference, since, as a rule, farm families are larger than city families.

When we consider separate states, however, we find some variations. In Illinois, Iowa, South Dakota, Nebraska, and California the average farm family seems to be about twice as wealthy as the average family (or perhaps three or four times as wealthy as the average city family), while toward the other extreme (omitting a few states that have less than 10 per cent of their population on farms) are Maine, New Hampshire, Pennsylvania, Delaware, West Virginia, Michigan, and several southeastern states, with about twice as much prosperity in the state as a whole as on farms. Statistics of illiteracy and magazine circulation also show a greater difference between city and country in the South than in the North and West.

We may next inquire what states gained or lost wealth during the recent war period. Taking the census figures literally, North Carolina increased 135.2 per cent in per capita wealth between 1912 and 1922, Tennessee 113.6 per cent, and South Dakota 112.9 per cent; while at the other extreme were Oklahoma with 12 per cent increase and North Dakota with 11.6 per cent increase. Those which gained less than 56 per cent and were therefore really poorer were, in descending order, New Jersey, Indiana, Kentucky, Oregon, Washington, Nevada, Alabama, Arkansas, Minnesota, Kansas, Montana, Nebraska, New York, Texas, Illinois, Iowa, Colorado, California, the District of Columbia, Oklahoma, and North Dakota.

So great variations among different states are hard to explain, and one might be inclined to suspect that the estimates are not very accurate. The figures can be checked to some extent by comparing the changes in value of farm property per farm between 1910 and 1920 with the changes in estimated per capita wealth between 1912 and 1922; for it does not seem likely that total wealth could increase much while farm property declined in value, or vice versa, except in densely populated states where farming is relatively insignificant.

The states which increased both in value of property per farm and in per capita wealth during the war and the years immediately before and after it (making allowance for the decline in purchasing power of the dollar), were South Dakota, Florida, Tennessee, and North Carolina; and they must therefore be regarded as having rather enterprising (or at least fortunate) inhabitants. Arizona, New Mexico, South Carolina, Georgia, Utah, and Virginia increased perceptibly in one particular but did not change much in the other; Missouri, Ohio, Kentucky, and Louisiana kept about the same rank in both; Illinois, Kansas, Texas, Oklahoma, and Alabama held their own in one and declined in the other; while Nevada, the District of Columbia, California, North Dakota, Washington, Montana, and New York declined in both respects and therefore presumably lowered their standards of living. The remaining 22 states gave contradictory results, gaining in one respect and losing in the other.

Whether the changes in standards of living that have been indicated above are due mainly to the migration or dying off of superior or inferior individuals or to changes in the prosperity of the same individuals or in the size of families cannot be told from the data available but deserve careful investigation in the states that have shown the greatest changes. The agricultural census of the United States that is planned for 1925 should throw considerable light on the subject, at any rate in the southern and western states.

ROLAND M. HARPER

Some Recent Geographical Bibliographies with Special Reference to North America. American students undertaking mature studies in the regional geography of their own continent cannot afford to neglect two European bibliographies that cover the subject. In the periodically issued volumes of the French *Bibliographie Géographique* and of the German *Geographisches Jahrbuch* will be found the only critical lists in existence of recent publications on the regional geography of North America.

The *Bibliographie Géographique* was reviewed in the *Geographical Review* for 1923 (Vol. 13, p. 480), and a plan for the co-operation of the American Geographical Society in its future publication was announced in the July, 1924, number of the *Review*, page 469. The *Geographisches Jahrbuch* first appeared in 1866 and has been continuously edited since 1880 by the veteran professor, Hermann Wagner, of the University of Göttingen. Each volume contains a series of summaries of the progress of recent investigation in various departments of geography with abundant footnote references to books, articles, and maps. Summaries dealing with the same topic are not repeated in every successive volume but only after intervals the duration of which depends largely upon the relative importance of the topic itself.

The current number of the *Geographisches Jahrbuch*, Vol. 39, 1919–23, was published in the spring of this year (1924). The dates "1919–23" on the title page are misleading, for the actual contents of the volume deal in large part with publications of an earlier date than 1919. Summaries are given of the progress of recent investigation in the following fields (figures in parentheses indicate the number of footnotes and hence, essentially, the number of publications referred to): historical geography of the Roman West, 1910–1914 (509); geographical meteorology, 1912–1916 (1560); the geomorphology of the earth's crust (*Dynamik der festen Erdrinde*), 1913–1921 (858); geophysics (129); regional geography of Africa, 1913–1922 (991); and regional geography of North America north of Mexico, 1914–1921 (1076).

We wish to call particular attention to the last-named summary. Professor Kurt Hassert of Dresden here continues and brings nearly to date a series of similar reviews contributed by Professor Emil Deckert to the *Jahrbuch* for 1914 and preceding years (for references see J. K. Wright: Aids to Geographical Research, *Amer. Geogr. Soc. Research Series No. 10*, New York, 1923, p. 42, footnote 5, No. 30). Professor Hassert introduces his study with apologies for omissions and points out the handicaps under which he labored in obtaining American publications as a result of the war and of post-war conditions in Germany. These apologies, we feel, are hardly necessary. The compiler seems to have "caught" not only everything that is obviously essential but also a large quantity of important and interesting items buried in government documents and in obscure periodicals and society proceedings. It is a revelation to scan his list and to observe the wide range of distinctively geographical writings that is being produced by various agencies in this country. The material is admirably organized and presented in systematic order. No less than 73 references are given to publications on the "continent as a whole," including a suggestive group on the Norse voyages. Some 76 references are to publications on Alaska. To British North America there are devoted at least 418, and

to the United States as many as 708. The material on the United States includes discussions of contributions to the study of natural regions, geology, climate, plant geography, problems of population and race (10 references on the negro question), economic geography, history of geography and exploration, followed by subsections devoted to the various regions of the country, with some 361 references to regional studies.

Two other recent works relating exclusively to North America also deserve mention. First there is the United States Bureau of Efficiency's "Report on the Statistical Work of the United States Government Submitted to Congress in Pursuance of the Acts of March 1, 1919 and November 4, 1919," Government Printing Office, Washington, 1923. This volume is a statement regarding the statistical activity and publications of the various bureaus, offices, commissions, and services of the government. The second publication is John M. Nickles' "Geologic Literature on North America, 1785–1918," Part I, Bibliography (forming *U. S. Geol. Survey Bull. 746*); Part II, Index (forming *U. S. Geol. Survey Bull. 747*), Government Printing Office, Washington, 1923. This, as is explained in the introduction, is in the main a cumulation of the series of bibliographies of North American geology that have hitherto been issued as *Bulletins* of the U. S. Geological Survey, "though many titles not found in these bulletins have been added as a result of the examination of the bibliographies on particular subjects issued by the Survey and many other special bibliographies and from other sources." Nickles' volumes will be indispensable for the geographer in search of material on the physiography or mineral resources of the continent.

Finally, reference should be made to a work of more general scope: Edward B. Mathews' "Catalogue of Published Bibliographies in Geology, 1896–1920" (*Bull. Natl. Research Council*, No. 36, Vol. 6, Part V, October, 1923). This is a simplified continuation of Emmanuel de Margerie's famous "Catalogue des Bibliographies Géologiques," Paris, 1895, and forms a list of bibliographies dealing with all branches of geology in all parts of the world. Arranged by topics and supplied with an authors' index, it incidentally includes references to bibliographies of the highest geographical value.

EUROPE

The View from Mont Blanc: Switzerland As Seen from the Air. A clear view of the entire horizon from a high mountain in our stormy latitudes is rarely to be had even by the mountaineer. M. Paul Helbronner by means of a remarkable panorama has made it possible for the sedentary reader to study the details of the immense prospect from Mont Blanc and to enjoy its marvelous colors. Painted in 1899–1900 from photographs taken in 1891 and 1893, the panorama has recently been published in photogravure reproduction (Paul Helbronner: Description géométrique détaillée des Alpes françaises, Annexe du Tome Second, Les origines iconographiques de l'oeuvre géodesique, Paris, 1921, Feuilles I à XIII. On the geodetic work of Helbronner as a whole see *La Géographie*, Vol. 37, 1922, pp. 117–131). The thirteen sheets of the panorama pasted together form a strip 19 feet 8 inches long by 25 inches wide. A key in black and white 4½ inches wide is given beneath the colored strip (upon which no names are written) making it possible to identify the details of the view.

The portfolio containing the panorama also includes views of the summit of Mont Blanc and its surrounding peaks from lesser eminences in the immediate vicinity. These show the light effects at different times of day. Especially impressive is a view of Mont Blanc from the Col de Géant at five o'clock in the morning in August. The rising sun tints the higher snows and rocks with delicate shades

of rose and orange while the lower crags are dark purples and violets, and the glacial ice a cold blue.

Though no photographs can vie with Helbronner's water colors in beauty, as an aid to geography-teaching Dr. Otto Flückiger's album of 243 airplane photographs of Switzerland will probably be even more valuable (Die Schweiz aus der Vogelschau, edited with introduction by Dr. Otto Flückiger, Zürich, Munich, and Leipzig, 1924). The geographical significance of the airplane photograph has often been commented upon (see, for instance, W. T. Lee: The Face of the Earth As Seen from the Air, *Amer. Geogr. Soc. Special Publication No. 4*, New York, 1922), but Dr. Flückiger's volume is probably the first in which a large number of airplane photographs have been systematically assembled and published to illustrate the geography of a fairly large area. In the introduction the editor discusses the physiographic and anthropogeographic features of three main regions of Switzerland: Alps, "Mittelland," and Jura. A further brief explanation interprets the specific and typical points of geographical interest revealed by the several photographs. So widely distributed and carefully selected are the views that almost no element in the visible geography of the country is unrepresented among them: complex and folded mountains, U- and V-shaped valleys, *névés*, glaciers, lakes, rivers, flood plains, deltas—all are displayed in a variety of forms in each case. Views of rural districts, with their diverse patterns of field and woodland supply an abundance of material for the human geographer. Students of city geography more particularly will profit from studying the views of towns, some taken at sufficiently low levels to show house forms, roof construction, and the intimate tracery of streets. The contrasting aspects of the country at different seasons are revealed, and, though most of the pictures were taken in clear weather, a few present characteristic views of clouds, haze, and mists nestling in the valleys.

In Helbronner's panorama we may look westward across the Rhone valley, over the site of Lyons (the city itself is masked by nearer hills), to the remote sky line of the Massif Central. Eastward the eye sweeps out to the plains of Piedmont and the northern Apennines. In Dr. Flückiger's volume large portions of Switzerland are often spread out below us in a single plate; one photograph embraces virtually the entire Lake of Lucerne with a vast expanse of intervening country. Mountain panoramas and airplane photographs give us an impression not only of the detailed forms and appearances of the various features which they depict but also a visual conception of areas which nothing else, short of actually seeing the country itself, can give. The importance of training in the visualization of areas is something that ought not to be overlooked in geographical education.

Ancient Types of Rural Dwellings in France. A generation ago Meitzen wrote his great tomes on settlement and agriculture, and a famous section of his work dealt with old types of houses. He ascribed the agglomerated village with its cornfields apportioned in strips in France to the Germanic invaders of post-Roman times, and with this came the idea that the Gallic house was a modification of the German house. It is said to have a steep roof, usually of thatch, façade under the edge of the roof, rectangular shape with the shorter side of the rectangle under the gable, a yard, one room for human beings and one for animals at first, and a barn above under the roof. Albert Dauzat in a recent paper in *La Nature* (January 26, 1924), however, shows that when one goes up into the Pyrenees from the plain of the Garonne and when one goes up into the Alps from the Rhone near Lyons one goes from the Mediterranean, or later, type of house, with fairly flat roof and other features detailed by the author, to this Gallic type. In other words he infers a spread of a later type in the plains both up the Rhone to about Tournus, with an important island beyond, and down the Garonne and northward in a coastal

zone to the Loire; and he concludes that this limited the distribution of an older type which he calls Gallic and supposes to date back to Roman times or beyond. His Norman type of house has its distribution interestingly correlated with that of several types of place names and with features of land tenure; it is often built with timber beams in the façade. Among his other types are the Flemish or Rhenish (Germanic), the Alpine, the Jurassic, the Basque, and others. A very interesting map accompanies the article, obviously a sketch to be amplified by further work; many striking departures from what might be considered geographic controls are noted. Lack of coincidence between boundaries of house types and boundaries of dialect is explained on the basis that the first conforms to relations chiefly from the first to the fifth century A. D., while the second became fixed from the seventh to the eleventh. More modern changes are noted here and there.

H. J. Fleure

The Geographical Position of Budapest. In the International Edition of *Földrajzi Közlemények: Bulletin of the Hungarian Geographical Society* (Vol. 41–46, 1913–19, Budapest, 1923, pp. 1–29) there is an article in English by Dr. Eugen de Cholnoky entitled "The Geographical Position of Budapest," a welcome contribution to a growing literature on city geography (see M. Aurousseau: Recent Contributions to Urban Geography: A Review, *Geogr. Rev.*, Vol. 14, 1924, pp. 444–455).

Dr. Cholnoky divides the Hungarian basin into six main productive regions. Separating these he conceives of *market lines* along which market places and market towns have sprung into existence where an exchange of the products of the different regions takes place. Among these lines the most important is one which runs from the vicinity of Agram (Zagreb) northeastward to Sátoraljaujhely along the southeastern foot of the highland zone separating the two plains of Hungary, the Greater from the Lesser Alföld. A normal position for a great city is at or near the point where the Danube cuts through the highland zone and across this market line. This passage of the Danube, centrally located in relation to the entire Hungarian basin, is, in the words of Dr. Cholnoky, "a remarkable spot full of geographical energy." It was essentially this circumstance that determined the growth of Budapest after the frontier of settlement had finally swept eastward into the Greater Alföld.

A combination of local topographic circumstances has favored the development of the town in its immediate site: the presence of a suitable river crossing here and here alone in a stretch of many miles up and down stream; easy land communication with the Little Alföld by way of the transverse valley of Vörösvár through the uplands to the northwest; a strong citadel in the fortress hill of Buda; an abundance of local building material.

Space forbids our following Dr. Cholnoky's illuminating discussion of the interior geography of Budapest, of the relations of the city to fluvial terraces, or of the floods to which the built-up section has occasionally been subjected where, in part, it occupies an abandoned channel of the Danube. The article is illustrated by a block diagram of the "morphology of the surroundings of Budapest." The author, though he has succeeded admirably in representing the surface features upon this diagram, has made no attempt to indicate the subterranean structure.

Distribution of Population in Norway. Sten De Geer's admirable map of distribution of people in Sweden (1917) has been extended to Norway by one of his pupils, Alfred Söderlund, with the same method of representing each 100 people by a black dot one millimeter in diameter, and towns of more than 3000 people by spheres whose volume represents the number of their inhabitants on the same scale. The result is a vivid presentation of the way the people of Norway cling to the coasts and the southeastern valleys, both city folk in 75 towns and cities and the

dwellers in the country (see Fig. 2, p. 507, a reproduction on a reduced scale of two portions of the map).

Norwegian authorities (Norges Geografiske Opmåling og det Statistiske Centralbyrå) who publish the work—"Folketetthetskart over Norge," Christiania, 1922, and text, "Befolkningens Fordelingen i Norge," Christiania, 1923—adopted a scale of 1:1,000,000, half that of De Geer's map for Sweden. Probably on that account Söderlund has omitted many of the physiographic and forestry data included on De Geer's map, limiting himself to black dots for population, red lines of communication, blue for hydrography and boundaries on a flat yellow tint, with an abundant selection of place names in light brown—all very clear. The smaller scale has of course the advantage of getting all Norway into the space of two sheets, which makes for ease of inspection. The distribution here shown was remarkably foretold by the impressionistic map in 1:3,600,000 published by the government in the work "Norway," prepared in 1900 for the Paris exposition; but Söderlund's work adds detail and expression, besides including the cities, which of course belong if the city folks are really folks. It is a picture of an inhospitable land, to every soil-covered spot of which men cling in swarms, everywhere close to great expanses of desert wastes. The cultivable earth is scarce. Only about Christiania Fiord and Lake Mjösen in the southeast are continuous patches of as much as a hundred square miles of tillable soil to be found. There live half the people of the country. People swarm too in the great eastern valleys that lead out from the Christiania region to the north and west—Östendal, Gudbrandsdal, Valdres, Hallingdal, and Numesdal. In Gudbrandsdal, especially, no mile is without human habitations, though Norway is one of the most sparsely peopled countries in the world. For this narrow strip of culture lies between twenty-mile-wide expanses of desert fell to right and left. The empty fell comes close to Christiania itself on the east and north, widening out notably in the western interior into the great wastes of the Hardanger Vidda, Jotunheim and Dovrefjell. But the coast settlements show most surprising continuity. Along the 1700-mile coast (in detail it develops into a 12,000-mile coast) it is only in the remotest north that one can find a ten-mile stretch without inhabitants. East of Christiansand (latitude 58° N.) there are 650 people to each linear mile of coast, north of Trondhjem there are 170, near Bodö 220, and at Hammerfest 120. The coast zone in which these people are included is 20 to 40 miles wide, the whole labyrinth of fiord, valley, and island passages making up the Norwegian coast. Except in the Christiania region the Norse people live close to the sea but almost invariably at the edge of an empty upland whose desert surface overhangs the salt water of the Atlantic.

MARK JEFFERSON

On the Late Quaternary History of the Baltic: A Reply. In an article "On the Late-Quaternary History of the Baltic" (*Geol. Fören. Förhandl.*, Vol. 46, 1924, pp. 172–179, Stockholm) Henrik Munthe gives his latest views of the late-Pleistocene changes of level of the Baltic especially as far as they disagree with views expressed by the undersigned ("On the Late-glacial and Post-glacial History of the Baltic," *Geogr. Rev.*, Vol. 12, 1922, pp. 602–612).

The highest limit of the Baltic ice lake before its drainage at the northern end of Mt. Billingen is put 40 to 55 meters higher than previously, and the highest marine limit on the western side of southern Billingen about 20 meters higher. The amount of the drainage of the Baltic ice lake at the northern end of Billingen is thus believed to have been about 56 meters. This view, however, is only one of five. G. Lundqvist ("Den baltiska issjöns tappning," *Geol. Fören. Förhandl.*, Vol. 43, 1921, pp. 381–385) thinks that the lowering was from 149 meters to 132 meters; S. Johansson ("Baltiska issjöns tappning," *Geol. Fören. Förhandl.*, Vol. 45, 1923, pp. 392–396),

without giving any elevations of beaches, thinks that the lowering exceeded 35 meters; M. Sauramo ("Studies on the Quaternary Varve Sediments in Southern Finland," *Bull. Comm. Géol. Finlande*, No. 60, 1923, pp. 125–128) believes that no drainage worth mentioning took place; and W. Ramsay ("On Relations Between Crustal Movements and Variations of Sea Level During the Late-Quaternary Time Especially in Fennoscandia," *Bull. Comm. Géol. Finlande*, No. 66, 1924, p. 27) thinks that the sinking was from 149 meters to between 112 and 120 meters. It is important to notice that Lundqvist and Ramsay agree regarding the elevations of the beaches although they disagree about their relative age. The beaches to which they attach importance also have been studied by other geologists. Therefore Munthe's new figures appear to be doubtful or to belong to small lakes ponded between the south-Swedish highland and the receding ice sheet. Whether Lundqvist's or Ramsay's view is the correct one is difficult to judge at present. The drainage of the Baltic ice lake at the northern end of Billingen consequently may have amounted to 17 meters (Lundqvist) or between 29 and 37 meters, say 33 meters (Ramsay). The threshold between Falster and the German mainland, the Darsser Schwelle, now reaching to within 18 meters of the surface, at that time must have stood at least (18 + 17) 35 meters or (18 + 33) 51 meters higher than now.

The depressions in the Öresund, the Belts, and the Cadet Rinne in the Darsser Schwelle are by Munthe still believed to be old river channels. Fortunately there is an excellent bathymetrical map of the region (Hans Spethmann; Tiefenkarte der Beltsee, *Petermanns Mitt.*, Vol. 57, II, 1911, pp. 246–251, Pl. 29). This map shows that the oblong depressions are separated by thresholds that are very high and wide. In the Little Belt, with the exception of a small kettle-shaped hole 81 meters deep, deep parts are lacking; wide sills rise even to between 20 and 10 meters from the water surface. But the deep hole of 81 meters in Munthe's mind nevertheless indicates the base of river erosion in Ancylus time. The depressions, as Gerard De Geer pointed out, most probably mark lines of fracture. Their present shape may be due partly to the activity of the land ice.

Of the facts set forth by Munthe as proof that the Baltic during the Ancylus stage was a lake and not an inland sea, only one is new. It is also, after more than 35 years, the first one of value; while the old facts can be readily explained under the assumption that the Baltic of that time was an inland sea. The new fact is the existence of an outlet channel in central Sweden of the Baltic during Ancylus time. The threshold lies about 15 meters above the contemporaneous sea, while the level of the Baltic stood 20 meters above the then sea.

Ernst Antevs

Ice Sheets and Isostasy: Relations in Fenno-Scandia. The relationship between the North European ice sheet and the late-glacial and post-glacial changes of level of Fenno-Scandia are discussed in a recent paper by Albrecht Penck ("Glaziale Krustenbewegungen," *Sitzungsber. Preuss. Akad. der Wiss.*, Vol. 24, 1922, pp. 305–314). He starts from T. F. Jamieson's theory—accepted by Gerard De Geer in 1890—that the post-glacial elevation of the glaciated regions was due to the disappearance of the ice which had locally weighed down the earth's surface and pressed out the underlying magma to the regions lying outside the glaciated area.

From the estimated volume of the last ice sheet, whose average thickness is assumed to have been 1000 meters, the amount of the magmatic displacement is calculated. The volume of the magma returned, figured from Henrik Munthe's isobases, is found to be only one-fourth of the quantity probably pressed out. The great difference is due to various causes. In the first place the elevation is greater than the isobases suggest because of the rise of sea level as the water imprisoned in the ice sheets was restored to the sea. This rising may have amounted to about

40 meters. In the second place upheaval occurred while the land was still covered by ice. Assuming a uniform rise, 7000 years is found to be the length of post-glacial time (it should be 8500) and 5000 years as the time of ice retreat from across Sweden. Using Munthe's isobases the author finds that the probable average upheaval of Fenno-Scandia, taking into consideration the rise of sea level, amounts to 212 meters. In the third place the true zero isobase lay far outside the apparent one. The area of upheaval practically coincided with the area of glaciation.

Even so, there is a great difference in the amount of magma pressed out and returned. This difference, however, is natural. Magma is still flowing towards the now rising area of Fenno-Scandia.

Theoretically it is probable that the rising, from being zero at the beginning of the ice retreat, increased and reached a maximum after the disappearance of the ice in order to decrease gradually to zero. This hypothesis seems to be supported by A. G. Högbom's survey of the oscillations of level. Under the assumption that the rhythm expressed by Högbom's curves of the oscillations for central and northern Sweden occurred in the whole of Fenno-Scandia, it is argued that the rate of upheaval increased from practically zero during the 15th millennium before the Christian era to a marked maximum during the 8th millennium after which it fell to an unimportant minimum during the 5th millennium, rose, and slowly decreased down to the present. Much the same problems are discussed by Fridtjof Nansen in "The Strandflat and Isostasy" (see below).

However interesting Penck's calculations are, they must not be taken too literally, since to a large degree they are based upon more or less unknown conditions. In the first place, it does not seem likely to the undersigned that magma corresponding to the weight of the ice ever was pressed out from the glaciated area. The ice probably began to retire before equilibrium was reached, judging from the fact that stability is not yet reached in the Baltic region so many thousand years after the disappearance of the load. Therefore the amount of outpressed magma calculated from the volume of the ice sheet may be too large. In the second place the figure 212 meters as the average amount of elevation is quite arbitrary. In reality it represents the average upheaval under the given conditions during the last 12,000 years. Rising probably occurred before that time. Therefore, and because the upheaval has been very irregular, we are not yet in a position to estimate the actual rise. The position of the zero isobase at the time of the greatest depression is not known. But at the uncovering northern Germany stood above the sea level of that time and actually at least as high as at present, provided that the sea level did not stand more than some 40 to 50 meters below that of the present time.

The rhythm of the oscillations of level in Sweden may not have been that assumed by Penck, who follows Högbom's survey. The subject is being studied by essentially new methods by Gerard De Geer, G. Lundqvist, and others; and our view of it is likely again to undergo fundamental changes. The present rise of Fenno-Scandia is only partly a direct continuation of the post-glacial rise. So, for instance, Bohuslän, which is now rising at a rate of 4 millimeters a year (10 meters in 2500 years), takes practically the same level as it did 2500 years ago.

Ernst Antevs

The Strandflat and Isostasy: A Further Comment. Fridtjof Nansen's important work "The Strandflat and Isostasy" (1922) was briefly reviewed by Professor W. M. Davis in the *Geographical Review*, Vol. 13, 1923, pp. 646–647. The present writer would here enlarge upon one of the aspects of the work—the problem of isostasy and late-Pleistocene changes of level in the Fenno-Scandian area (compare the preceding note).

The Norwegian strandflat may have been formed by the joint action of subaerial erosion by frost, local glaciers, etc., and of marine shore denudation by frost and wave action since the coast had been dissected by numerous fiords and channels and especially before, during, and after each glacial period. On the whole, the levels of the strandflat appear now to stand at similar inconsiderable heights above the sea in all parts of the Norwegian coast where they have been studied. A computation of existing data on the late-glacial and post-glacial upheaval of the Norwegian coast regions from Christiania to the Kola Peninsula tends to show that this upheaval has proceeded with remarkable regularity and uniformity. These facts constitute conclusive evidence that the earth's crust in these regions has very nearly returned to the same horizontal position it had before the last glacial submergence, except that the shore line then stood perhaps between 10 and 17 meters higher, in relation to the land, than it does now. "The uniform relation which we have found between the heights of the observed upper limit of late-glacial submergence and those of the Tapes line confirms in a striking manner the correctness of these conclusions" (p. 273). The upheaval of the land along the whole Norwegian coast may have practically ended. The Tapes-Littorina submergence—the only interruption of the upheaval which Nansen discusses—cannot be explained as an isostatic phenomenon but may be due to transgression because of rapid rise of the sea level while Fenno-Scandia except South Sweden was slowly rising. The rise of the sea may have been due to the melting of ice caps and glaciers because of the high temperature at that time. The subsequent drop in temperature may have caused an increase of the ice caps and sinking of the sea level. The different stages or interruptions in the upheaval of the land, marked by a series of marine terraces and raised beaches along the coast of Norway, may be similarly explained.

Thus, the strandflat probably since pre-glacial time has represented the level of isostasy at times when the land was not depressed by a load of ice; for otherwise it seems to be inconceivable that the crust should always return to the same horizontal level after each depression. Thus, it may be inferred "that the earth's crust is on the whole very responsive to disturbances of its equilibrium and has a great ability to re-establish it. After a sufficient time it will attain its level of isostasy at least within some few meters" (p. 296).

The vertical coastal movements in Fenno-Scandia are explained in the old well-known way essentially by outpressing and subsequent return of magma caused by the loading and the subsequent unloading of the ice.

Calculating on the basis of an extension of all the Pleistocene ice sheets during their maximum development of 50 million square kilometers and an average thickness of the ice sheet of 1000 meters, Nansen finds that the sinking of the general sea level during the climax of glaciation may have amounted to 100 meters at least and perhaps to as much as 150 meters. The value of Nansen's conclusions depends largely upon whether or not his explanation of the formation of the strandflat is correct. If it is correct the ancillary results are remarkable indeed and very far-reaching. However, the great uniformity of the changes of level which Nansen's view postulates appears to be a weak point. Regarding late-glacial and post-glacial oscillations of level other students of the subject find less uniformity. For instance, J. Rekstad's map of the late-glacial submergence ("Norges hevning efter istiden," *Norges Geol. Undersökelse No. 96*, Christiania, 1922) shows a more irregular course of the isobases than does Nansen's map (Fig. 166, p. 255). The reason is that Nansen has sifted the material (see, for instance, pp. 248, 254, 262, and 272).

When Nansen ascribes the Tapes-Littorina transgression largely to ice melting, he overlooks the known fact that the warmth maximum fell substantially later in time than the transgression. Terraces and shore lines formed during the upheaval were more likely due to land upheaval by jerks than to rise of the sea level. Because of the rigidity of the earth's crust upheaval may have begun when equilibrium was

surpassed, and through inertia it may have proceeded rapidly so as to surpass the state of equilibrium in the other direction. If the upheaval had proceeded only a little too far, the level was kept, especially as the ice load was continually decreasing; but if it proceeded far beyond the point of equilibrium a movement in the opposite direction and a sinking of the land resulted. This may have been the essential cause of the oscillations of land in Fenno-Scandia during the general upheaval.

Ernst Antevs

The Economic and Political Status of Russia in 1923. Information drawn in large part from the Russian periodical press and relating to the economic and political situation of Russia in 1923 is summarized in a note by P. Deffontaines in *La Géographie* for February, 1924 (Vol. 41, pp. 187–196).

From the agricultural point of view, Russia in 1923 had once more become a country of export after the famine years of 1920 and 1921. An effort was being made by the Soviet authorities to encourage improvements in agricultural methods through the introduction of model farms and to bring about a more productive utilization of field and forest by establishing new agricultural communities and by granting concessions to foreigners on a large scale. Vast tracts of forest in the basins of the northern Dvina and Vichegda have been conceded to Anglo-Russian and Dutch-Russian concerns.

A commercial and industrial crisis occurred in 1923, the result of "the lack of financial means, leading to great difficulties in selling and buying merchandise, and of the cessation of all active operation on the part of the banks." Selling below cost and overproduction were general in many industries, and as a consequence many establishments had to close down. Figures for the foreign trade of Russia for 1922 as compared with those for 1913 show that imports from Germany had fallen from 57.5 per cent to 33 per cent of the total imports, though the latter percentage was double that of 1921. Imports from the United States showed an increase from 8 per cent in 1913 to 14 per cent in 1922; those from England in the same years of from 12 per cent to 18 per cent. Thirty per cent of the 1922 exports of Russia found their way to England; exports to Germany in that year were negligible, though the situation was materially altered in 1923 by the resumption of the exporting of Russian cereals.

Monsieur Deffontaines states that "the fact which dominates the entire political situation of present-day Russia is the disintegration of the Russian nation." By granting autonomy to the ethnic stocks of the former empire and by encouraging the use of local languages "the Soviets have to some extent organized and stimulated this disintegration." Other authorities see a trend in the opposite direction. W. Gerbing, in an article entitled "Das neue Russland" (*Geogr. Zeitschr.*, Vol. 29, 1923, pp. 197–205), asserts that "in the contemporary administrative division of Russia we may perceive the attempt to found anew and to strengthen the dominance of Great Russia, while at the same time the newly awakened national feeling of the numerous non-Russian peoples is indulged." Monsieur Deffontaines considers the recent change in the name of the body politic as a whole from "Russian Federated Socialist Soviet Republic" to "Union of the Socialist Soviet Republics" as if it were a further concession toward a policy of decentralization. Gerbing, on the other hand, regards it as symbolizing a change from a loose federation of half-sovereign states into a genuine union, or, as he puts it, from a *Staatenbund* to a *Bundesstaat*, and this view is confirmed in the recent well-documented volume of A. L. P. Dennis, "The Foreign Policies of Soviet Russia" (New York, 1924), pp. 189–196, as well as in Captain Kelly's article in the present number of the Review.

AFRICA

The Practice of Transhumance in Basutoland. Basutoland falls into two major natural regions: the lowland sandstone country of the west, the Basutoland of the natives, and the volcanic upland country—the Malutis of the natives. The upland is a maturely dissected plateau with elevation ranging from about 6500 to 11,170 feet in the culminating peak of the Drakensberg and is limited by eastern and western escarpments, the Drakensberg and Malutis. The rock weathers to a fertile black soil which grows excellent crops of wheat. But the Basuto greatly prefers maize or Kafir corn as a staple, and the population of the country is still concentrated in the warm lowlands. The long steep grassy slopes of the uplands are used as pasture for the Basuto's wealth of cattle, sheep, and goats. Associated with the cattle industry is the practice of transhumance (R. U. Sayce: An Ethno-geographical Essay on Basutoland, *Geogr. Teacher*, No. 68, Vol. 12, 1924, Spring, pp. 266–288, London).

In autumn the cattle come down from the mountains. The precise date is set by the time of harvest, for they are grazed on the stalks of the garnered maize and corn; and, when this fodder is exhausted, on the winter veld, pasture near the village demarcated and set aside in the spring for this purpose. In Basutoland there is no private ownership of land; agricultural allotments are made each spring by the chief, who also declares the grain fields and the winter veld open for common grazing towards the end of May or the beginning of June. The winter pasture available is limited, and the cattle are usually in poor condition by the end of the winter when the great spring movement takes place. About August early rains—Basutoland is a region of summer rain—have revivified the mountain pastures, and the homelands are waiting to be plowed. A few cattle are kept behind for milk and plowing, the rest go to the mountains under the charge of herdboys "old enough to know the cattle marks." Little ceremony attends the proceeding. Distances traveled vary: it may be a matter of a few hours or a day or several days' journey. Some exchange of beasts goes on all summer, and in certain particularly rich agricultural districts where considerable numbers of cattle are kept at the villages there may be a large secondary migration towards the end of December and January. Where the mountain posts are large, cattle, sheep, and goats are looked after separately; but usually two boys care jointly for flocks and herds. When the cattle come down, the sheep and goats usually remain behind under the care of a single boy.

The pressure of increasing population is, however, making itself felt in Basutoland. Formerly a man could have as much agricultural land as he could cultivate; now he is limited to three plots, each 100 by 150 yards. The population is spreading into the mountains; permanent villages and cultivation are taking the place of the cattle posts; and a taste for wheat and extension of the crop is being perforce developed. Associated is a growth of individualism and private ownership. Migration movements are being correspondingly restricted. As in other lands of more advanced civilization, transhumance is on the wane in Basutoland (Philippe Arbos: The Geography of Pastoral Life, Illustrated with European Examples, *Geogr. Rev.*, Vol. 13, pp. 559–575). A change in the character of the pastoral industry or its decline is connoted; as it is, the pastures are overstocked, and the range has deteriorated as elsewhere in South Africa.

ASIA

Some Recent Maps of Central Asia. During his expeditions in Central Asia (1900–1901, 1906–1908, and 1913–1916) Sir Aurel Stein enjoyed the full co-operation of the Survey of India. As a result, in addition to making the archeological discoveries that have amazed the scholarly world, he was able to carry out carto-

graphical work of primary importance. The definitive cartographical results of the three journeys have been embodied in a series of 47 maps (1:500,000) accompanied by a volume entitled "Memoir on Maps of Chinese Turkistan and Kansu from the Surveys Made During Sir Aurel Stein's Explorations, 1900–1, 1906–8, 1913–5" (Records of the Survey of India, Vol. 17, Trigonometrical Survey Office, Dehra Dun, 1923). These maps supersede the 94 maps (1:253,440) based upon the expedition of 1906–1908 and published as the fifth volume of "Serindia" (see *Geogr. Rev.*, Vol. 12, 1922, p. 662).

Stein explains in the introductory note to the "Memoir" that "improved methods of drawing and reproduction have allowed in the new maps a clearer and fuller representation of [the record of his surveys] than was possible in previous publications." The scale of the new maps is smaller than that of the 1:253,440 sheets. On the other hand, the new maps reveal all the details that are shown upon the older, as well as various corrections made in the light of more recent data. The representation of relief by form lines (or rough contours) rather than by hachures is more precise. Furthermore, the 1:500,000 series shows the results of all three expeditions whereas the 1:253,440 series shows those of but one expedition only.

The detailed topography of the new maps has been exclusively derived from the plane-table surveys carried out by Stein's parties. These plane-table surveys were based upon the triangulation and astronomically determined latitudes of the Indian surveyors, Rām Singh and Lāl Singh, under Stein's orders. The triangulation in turn was to a very large extent based upon Captain H. H. P. Deasy's triangulation in the Pamirs and Kunlun (1897–1899), though the work of a few other explorers was also drawn upon for latitudes and longitudes. Major Mason, commenting on the triangulation in an appendix to the "Memoir," highly commends its accuracy; he adds, however, that "it is absolutely necessary to lay stress on the fact that it is in the nature of pioneer work and that when the regularly connected triangulation of the Survey of India reaches the areas concerned, the points of Rām Singh and Lāl Singh will be superseded. . . ."

The "Memoir" gives a brief history of Stein's expeditions, a general description of the regions surveyed, a discussion of the compilation and content of the maps themselves with notes on the individual sheets, and an index of local names. Appendixes by Major Kenneth Mason and Dr. J. De Graaff Hunter, both of the Survey of India, treat respectively of triangulation and altitude observations. The volume concludes with a series of photographs.

The general description is an outline of the essential features both of the physical and the human geography of this immense but little-known part of Asia. Though the entire tract has been described at length in Stein's earlier works (to which detailed references are given in the footnotes) all students will appreciate having the material presented in condensed and concise form. The descriptions of the individual sheets not only explain the technicalities of the survey work from which each sheet was constructed but also give brief accounts of the more striking points illustrated by each, again with references to Stein's earlier works. Great care was given to the accurate recording and transliteration of local names as shown on the maps and listed alphabetically in the index. The "Memoir," in short, should serve as a guide of exceptional utility for all who would undertake studies, either general or detailed, in the geography of Central Asia.

Another important recent map of Central Asia is Colonel A. H. Byström's "General Map of Eastern Turkestan and Tibet on the scale of 1: 1,000,000, embracing Dr. Sven Hedin's routes 1894–1908 and those of other recent travelers as well as the most important materials existing," Lithographic Institute of the General Staff of the Swedish Army, Stockholm (undated). This is included in the map supplement to Sven Hedin's "Southern Tibet," 9 vols., Stockholm, 1916–1922. As the title implies, it is a compilation from various sources and consequently may be

used to fill in many of the gaps left by Stein's maps. As Byström's map appeared before Stein's 1: 500,000 series, it does not show the results of Stein's explorations of 1913–1916 nor the various corrections of the latter's earlier maps. Colonel Byström's production is highly artistic and is beautifully engraved. Relief, however, represented by brown shading, is less precise than upon the maps of Stein.

AUSTRALASIA AND OCEANIA

Exploration in Papua. A half century ago the interior of Papua (the official name of southeastern New Guinea) was absolutely unexplored, and even the coasts were imperfectly known. So complete was European ignorance of this region in 1875 that a certain Captain (?) Lawson had the audacity to publish a book describing a wholly fictitious expedition across the island from south to north in the course of which a vast lake and a mountain 32,783 feet high were encountered (J. A. Lawson: Wanderings in the Interior of New Guinea, London, 1875. Lawson's statements, which won some recognition, were refuted by Captain John Moresby in his "Discoveries and Surveys in New Guinea and the D'Entrecasteaux Islands," London, 1876, pp. 321–327). Even as late as 1912 Judge J. H. P. Murray, lieutenant governor of Papua, opened the chapters on the history of Papuan exploration in his authoritative volume, "Papua, or British New Guinea" (reviewed in *Geogr. Rev.*, Vol. 1, 1916, p. 163), with these words: "Papua has been British for nearly thirty years, but half of it is still totally unexplored, and of the other half there is but a comparatively small portion that is really well known" (p. 247). Light had been thrown on much of the eastern half of the territory by the important journeys of Sir William MacGregor in the nineties, and by the reports of government officials, prospectors, and miners. The western half, except for the courses of the main rivers—and of only a few of these—was still *terra incognita.*

The last decade, however, has seen the steady progress of exploration "by magistrates and others as part of their ordinary duty," with such significant results that Judge Murray is able to assert in a recent pamphlet (J. H. P. Murray: Recent Exploration in Papua, Sydney, n. d. [1922 or later]) that "there is really very little left to explore now in Papua, beyond a block east of the Strickland and north and northeast of the Samberigi Valley. Practically all the country west of the Fly has been examined, including the extreme N. W. corner [see Leo Austen: The Tedi River District of Papua, *Geogr. Journ.*, Vol. 62, 1923, pp. 335–349], and the unknown country is now confined almost entirely to the eastern part of the Western Division, and the west and north of the Delta Division" (p. 5). The official accounts of these explorations are given in paper-covered volumes, unprepossessing in appearance but filled with information of absorbing interest, the *Annual Reports* of the Papuan administration submitted to the Australian Parliament; more rarely in books like W. R. Humphries' "Patrolling in Papua," London, 1923, or the two works by Captain Monckton reviewed in the *Geographical Review* for April, 1924, pp. 331–332.

Judge Murray's pamphlet from which we have quoted is of value because it gives a concise summary of the work of exploration since about 1912. It is largely the record of observations of police patrols and other official missions and is illustrated with rough sketch maps. Without attempting even to summarize the topographical details presented, we may mention briefly a few of the more striking discoveries.

In the country east of the Strickland River Ryan in 1913 found what appeared to be "an abundance of coal," of which he wrote, "The surface coal is of no commercial value, but, in my opinion, it indicates that coal of a superior quality may

be met with on sinking below the surface" (quoted by Murray, "Recent Exploration," p. 35; see also J. E. Carne: Notes on the Occurrence of Coal, Petroleum, and Copper in Papua, *Bull. of the Territory of Papua No. 1*, Melbourne, 1913, reviewed in *Geogr. Rev.*, Vol. 1, 1916, p. 76). In 1922 Flint and Saunders examined the region north, northwest, and northeast of Mt. Murray, part of which had been traversed by Miles Staniforth Smith in 1910 (see *Geogr. Journ.*, Vol. 39, 1912, pp. 313–334). Here the Samberigi Valley was explored, a broad, open, cultivated hollow in the midst of imposing mountains, having an estimated area of 105 square miles and supporting a native population of 2000. Skelly and Swanson in 1917 reported natives dwelling at an altitude of 8000 feet in the Albert Mountains, a circumstance which Murray pronounces exceptional, "though altitudes of about 6000 are not unusual" (p. 24). In the eastern part of the highlands natives were seen by Jackson in 1914 carrying on "extensive burning-off operations at a height of just under 10,000 feet. It appears that they were hunting cuscus [a small marsupial], and it is probable that hunting parties occasionally visit even higher altitudes, but so far as I am aware no regular villages have been seen at a greater height than 8000 or even 7000 feet" (p. 19). British travelers frequently suffered severely from cold on the mountains. On a journey up the Strickland in 1917, Judge Murray writes (p. 37) that he saw no trace of human beings for a distance of more than one hundred miles and suggests that the natives of this district may well have exterminated each other. Commenting upon the hideous and revolting evidences of a massacre found by Baker in the same region in 1913, Murray observes that "practices such as these are not conducive to an increase of population, and perhaps it is not to be wondered at that the banks of the Strickland, when I was there, bore no trace of human existence" (p. 38).

To abolish this "almost insane craving for bloodshed" and to guide the Papuans towards the blessings and away from the evils of civilization are the outstanding problems of the local administrator. Judge Murray, who is keenly sympathetic in his understanding of the native mentality, regards these folk as "very intelligent people at a low stage of development." On their characteristics and on other problems of present-day Papua he has published an illuminating paper ("Papua of To-day," *United Empire*, Vol. 14, 1923, pp. 352–362) which should be read in conjunction with his pamphlet on exploration by all who may wish to gain some knowledge of recent events and contemporary conditions in one of the most obscure but most interesting corners of the British Empire.

The Ice Age and the Antiquity of Man in Australia. Professor David delivered the R. M. Johnston Memorial Lecture in Hobart on October 8, 1923, choosing for his subject the antiquity of man in Australia (Sir T. W. Edgeworth David: Geological Evidence of the Antiquity of Man in the Commonwealth, with Special Reference to the Tasmanian Aborigines. R. M. Johnston Memorial Lecture, *Papers and Proc. Royal Soc. of Tasmania for the Year 1923*, Hobart, 1924, pp. 109–150). Aside from the main subject, the address marks a critical point in the history of Australian Quaternary geology. Tasmania was the scene of rather intense Pleistocene glaciation. Owing to the latitude of the island, it is more likely than is the mainland of Australia to show whether or not the course of events in glacial time was in harmony with that in other intensely glaciated regions of the world. Ten years ago the Australian geologists were aware of the extent of glaciation but were too cautious to attempt correlation. Recently some work of great importance has been done by Benson, Griffith Taylor, and others; and Professor David has now revealed in his address an underlying acceptance of correlation with the broad subdivisions of the Ice Age of the northern hemisphere. This means that Australia has a time scale for the Quaternary, a matter of immense importance in archeological studies.

The past of a new country long remains a blank to its occupants. Knowledge of the Australian native is scanty enough, and archeological knowledge is of the slowest growth. Records are found at rare intervals, and even the light of geology that can be brought to bear on them is sometimes uncertain. Here, too, the recent past has been fruitful of results. Artifacts of primitive workmanship have been found in several widely separated parts of Tasmania, and the conditions of their occurrence have been carefully investigated. With these discoveries as a starting point, Professor David has reviewed all that is known of the history of man in Australia, applying the newest results in glacial geology, physiography, the paleontology of the Quaternary fauna, and anthropology. The synthetic method has been brilliantly successful. It demonstrates that man existed in Tasmania from remote antiquity and that his geological history on the mainland is longer than hitherto suspected. Admitting that the correlation is tentative, David seems to have placed his main conclusions beyond doubt. It has long been believed that the Tasmanian aboriginal was an earlier arrival than the Australian, who brought the dingo. The Tasmanian artifact from the Doone Mine near Gladstone is placed tentatively as belonging to the Würm or even to the Riss Glaciation; while the celebrated Talgai skull from near Warwick, Queensland, is placed in the Riss-Würm Interglacial Epoch and is considered by David to be Australian rather than Tasmanian. And Tasmania was undoubtedly peopled before Australia!

The paper, which is illustrated with maps, sections, etc., initiates an admirable grade of precision in Australian archeology.

MATHEMATICAL GEOGRAPHY

The Study of Maps. An attractive little book for teachers of geography is Sir Herbert George Fordham's "Maps: Their History, Characteristics and Uses; a Hand-book for Teachers" (The University Press, Cambridge, 1921). Though primarily intended to explain the elements of cartography, the volume lays much stress on the historical background. Its author conceives of the modern map as the product of development that may be traced from the earliest antiquity. While instruction in the history of maps is too advanced for elementary schools, Sir Herbert feels that the teacher should have some knowledge of this field. There is much to be said for this opinion. The need is great for unpretentious books like this, presenting other phases of geography in their historical perspective.

Sir Herbert asserts that "in the second half of the last century, map-engraving seems to have lost its beauty and originality, probably in view of the rigid uniformity of expression demanded of it." "In the choice of elements of graphic expression in relation to the pictorial features of maps there has been a gradual elimination of unsuitable signs, and the 'survival of the fittest' has produced a stereotyped uniformity—very essential in cartography, now an exact and highly-developed science." Map making in earlier days was a fine art as well as a science. Sir Herbert speaks enthusiastically of several exceptionally handsome maps of the earlier period. "Nothing," he writes, "attains to the beauty of the two large maps of the district and bay of Naples by Rizzi-Zannoni . . . of the end of the eighteenth century. The surface of the map is of marvellously minute execution, the panoramic representation of the coast-line on one of these maps is a lovely piece of work, and the borders and other ornamental features are superb."

Otherwise admirable as this little book is, there are two matters which cannot be passed over.

The invention of the contour line for representing relief was one of the most important contributions to the progress of modern cartography. On page 47 Sir

Herbert makes the misleading statement that contours "were first adopted in France, on the suggestion of Laplace, in 1816." They had been employed, however, in mapping the bed of a river channel as early as 1728. Dupain-Triel's map of France with contour lines was published in 1791. The method was certainly well known, even if it had not been widely used, before 1816. (See Anton Steinhauser: Beiträge zur Geschichte der Entstehung und Ausbildung der Niveaukarten, sowohl See- als Landkarten, *Mitt. K. K. Geogr. Gesell. in Wien.*, Vol. 2, 1858, Abhandlungen, pp. 58–74; reference on p. 60; and Henri Zondervan: Allgemeine Kartenkunde, Leipzig, 1901, p. 53.)

The other point is the omission of any discussion of the problem of representing the spherical surface of the earth on a flat surface, an omission that was probably intentional in view of the difficulty and technicality of the subject. It is, nevertheless, one of the major problems of cartography. Even if they may not be expected to master the mathematical details, we cannot but feel that all teachers and students should know at least that this problem exists and should know something of the efforts that have been made toward its solution. Sir Herbert's treatment passes it by altogether.

Besides the book described above, Sir Herbert has published during the last twenty-five years a number of studies in the "cartobibliography" of various regions and types of map. Among the more recent of these is a note in the *Bulletin de la Société Royale Belge de Géographie*, Vol. 47, 1923, pp. 35–43, in which he emphasizes the historical importance of old maps and the desirability of their systematic listing. References are here given to other papers by Sir Herbert. In an address delivered at the University of Manchester on the "Evolution of the Maps of the British Isles" (The University Press, Manchester, 1923), he outlined very briefly the outstanding events in the history of cartography in the British Isles prior to the work of the Ordnance Survey.

PHYSICAL GEOGRAPHY

Seasonal Abnormalities of World Weather. Dr. Gilbert T. Walker's paper, "A Preliminary Study of World-Weather," is eighth in the series "Correlation in Seasonal Variations of Weather" of the memoirs of the Indian Meteorological Department (Vol. 26, Part IV, Calcutta, 1923). Dr. Walker has gone over in detail all previous work on the subject and has brought up to date, with the most recent records available, a great many of the seasonal weather correlations worked out earlier by himself and others. He finds in many cases that apparently excellent correlations indicated by 20 or 30 years' records do not show when 40 or more years are used. His paper demonstrates how important is caution in interpreting even high correlation coefficients when these coefficients are no more than double or treble the probable error.

Dr. Walker first discusses in some detail the correlations between sunspots and pressure, temperature, winds, cloud, and rain. He finds that with an abnormally large number of sunspots annual pressure is affected irregularly; annual temperature is, in general, lowered particularly in the tropics; the effect on winds is uncertain; cloudiness in India is apparently slightly increased, except in the hot weather, April and May; and rainfall is affected irregularly, heavier rain, in general, going with lower pressure.

A comparison of temperatures at some stations in India with values of the solar constant has been made by Dr. Walker for the summer months 1905, 1906, and 1908–1920. He finds that ". . . apart from rainfall the solar constant has a corr. coeff. of about +.30 with temp." The coefficients for some other tropical and subtropical stations run about like that of India, +.3 to +.4, values not large

enough to be more than suggestive. Dr. Walker's general conclusion is that "for explaining the weather abnormalities of the seasons the variations of the solar radiation are inadequate, and we must seek the reasons in the previous distribution of seasonal features over the earth. In this conclusion we disagree with the widely prevailing idea that such abnormalities are an immediate consequence of changes in the heat given out by the sun. As a definite example I know of nothing in solar physics to explain without reference to previous terrestrial conditions the contrast between the biggest Indian monsoon on record in 1917 and the monsoon in 1918 that has only been surpassed in scantiness twice in the last sixty years."

For discussing relationships between centers of action of the atmosphere, Dr. Walker chooses 15 pressure centers and 6 precipitation centers. The North Atlantic high is divided into two parts, represented by the pressures at Punta Delgada, Azores, 1875–1921, and Charleston, S. C., 1875–1919. Of the rainfall centers only those of the peninsula of India and Java are discussed at length. For each of the 15 pressure centers and each of these two rainfall centers Dr. Walker presents the correlation coefficients with all the others for winter and for summer, for the same season, and the seasons two quarters before and after. These represent, truly, a prodigious amount of tabulation and computation. For all regions except the North Pacific or Alaska low, Honolulu, the south tropical Pacific (Apia, Samoa), and the southern low (Laurie Islands, S. Orkneys), the data cover homogeneous periods of about 30 to 46 years. Correlation coefficients, therefore, of .4 or greater are probably significant except for the centers mentioned.

The atmospheric centers of action directly affecting the seasonal weather of North America are not only interrelated more or less strikingly at the same season but also have their variations indicated to some degree half a year in advance at distant centers. South Alaska and Hawaiian pressures are inversely correlated (—.71 (?) in winter), just as are those of Iceland and the Azores (—.54 in winter) and Iceland and Charleston, S. C. (—.33 in winter). Rather unexpected are the large correlations between Charleston pressures and those of Port Darwin (N. Australia) and Northwest India, both —.52 in winter, and between Charleston pressures and those of Northwest India and St. Helena, —.51 and +.49 in summer. The correlation coefficient —.36 between the pressure of Central Siberia, June to August, and that at Charleston the following December to February may be significant. "We can perhaps best sum up the situation by saying that there is a swaying of pressure on a big scale backwards and forwards between the Pacific Ocean and the Indian Ocean, and there are swayings, on a much smaller scale, between the Azores and Iceland, and between the areas of high and low pressure in the N. Pacific: Further, there is a marked tendency for the 'highs' of the last two swayings to be accentuated when pressure in the Pacific is raised and that in the Indian Ocean lowered."

As a result of Dr. Walker's studies it seems to have become possible not only to increase the accuracy of the long-range forecasts made of the monsoon rainfall of India but also to make these forecasts as early as the end of February preceding the summer monsoon and even to make forecasts of the winter rains. Dr. Walker is now engaged in closer studies by months of the most significant correlations.

These world-wide reactions of the weather are evidently closely connected with the slowly moving ocean currents in which solar or wind-made temperature abnormalities persist for months. The fact that seasonal weather abnormalities in different parts of the world show stronger relations among themselves than with solar changes need not cause us to relegate to a minor position the study of solar variations and terrestrial weather changes. The solar changes may from time to time strengthen and thereby maintain the reactions between terrestrial pressure centers which otherwise might become appreciably weaker.

Charles F. Brooks

Mediterranean Climates of Eurasia and the Americas. H. A. Matthews has nine pages in the *Scottish Geographical Magazine* for May on the *dissimilarities* between the Mediterranean climates of Eurasia and those of the Americas, stressing the upwelling cold waters on American west coasts, which Europe lacks, and with them the striking coolness of American west-coast summers; and likewise the penetration of the Eurasian Mediterranean so far into the subtropical lands, which goes with the east-west structure of the old Mediterranean ridges, where America has north-south lines of plateau and ridge.

Corresponding differences in the winds and in the degree of prevalence of winter rains are pointed out.

While indicating the way in which these contrasts modify the analogies, the author makes it clear that he regards the similarity of all the west-facing subtropical shores as the major character.

MARK JEFFERSON

HUMAN GEOGRAPHY

Geography in Literature. Some men of letters are endowed with a highly developed geographical instinct. As writers, they have trained themselves to visualize even more clearly than the professional geographer those regional elements of the earth's surface most significant to the general run of humanity. Geographers, however, have devoted but little attention to this fascinating subject of geography in literature. H. R. Mill's useful "Guide to Geographical Books and Appliances," London, 1910, contains a chapter in which the plea is made that in educational value the "geographical novel" be recognized as on a par with the historical. Mill distinguishes between the multitude of works of fiction revealing merely "local color" and those that are distinctly geographical, and he briefly discusses some of the best among the latter. In 1920 Miss D. Wharton edited for the Leeds Branch of the British Geographical Association a "Short List of Novels and Literary Works of Geographic Interest," intended to "help make the world really alive to students of geography." This list is suggestive, if of somewhat uneven quality.

Students of the history and trends of literature, on the other hand, have gone into the matter in no little detail, especially in relation to the local-color movement of the last half century. An entertaining chapter on the quest for local color will be found in W. P. James' delightful book, "The Lure of the Map," London, 1920 (reviewed in *Geogr. Rev.*, Vol. 11, 1921, p. 160). Local color is an evasive quality, revealing itself in different hues to different seekers. It exists, none the less, and the geographer should be among the last to disdain its existence. A colorless regional monography falls short of the geographical truth.

Some understanding of the local-color movement in the United States may be gained from Robert L. Ramsay's "Short Stories of America," Boston, 1921. This volume, edited primarily for classroom work in English composition courses, includes a selection of sixteen short stories illustrative of various ways in which local color may be depicted. Dr. Ramsay shows his appreciation of geographical values by partitioning the United States and Alaska into five major divisions and twenty-five subordinate "local-color states" and by drawing their boundaries on a map (Fig. 2). These boundaries do not coincide with those of political states but mark off from one another wholly independent regions each one characterized by a sufficiently individualistic type of life to have given rise to a distinctive type of story. There is no slight measure of correspondence between Dr. Ramsay's literary provinces and the physiographic, climatic, and vegetational regions of the geographers.

The map also shows certain neutral zones, which "probably because of their transitional location . . . have as yet attracted but little attention from local colorists." Dr. Ramsay's book closes with a series of reading lists giving the titles of seventy-five stories arranged according to the twenty-five "local-color states" which they illustrate.

A similar compilation for France, intended, however, not for the student of composition but rather for the mature general reader, is Septime Gorceix's "Le Miroir de la France: Géographie Littéraire des Grands Regions Françaises," Paris, 1923. Here, instead of short stories, a selection is made of excerpts from novels, poems, essays, and descriptions, chosen for the poignancy with which they depict the various *pays* and cities of France. The *pays* are defined in the preface by Jérôme and

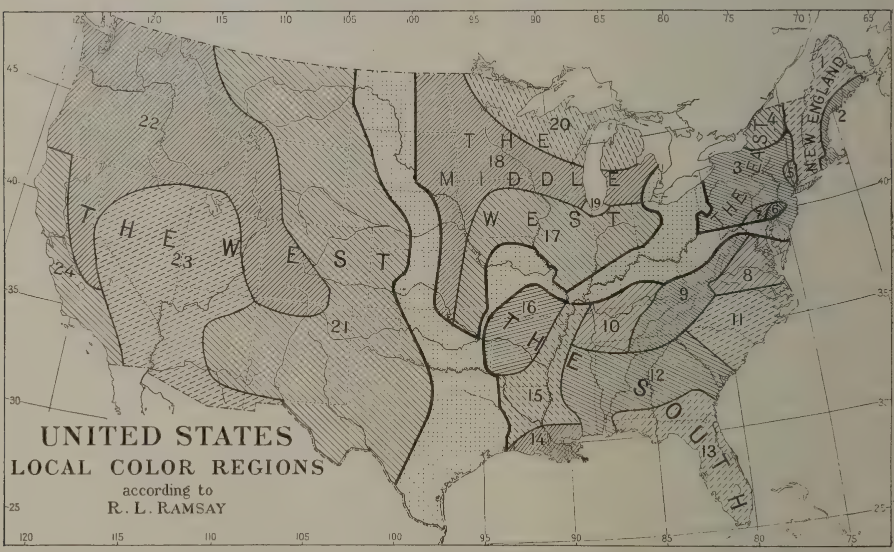

FIG. 1—Local color regions of the United States according to R. L. Ramsay. 1, Old New England; 2, the New England Coast; 3, the Middle East; 4, Upper New York; 5, New York City; 6, Philadelphia; 7, the Pennsylvania Dutch; 8, the Old Dominion; 9, Appalachia; 10, the Blue Grass; 11, the Middle South; 12, the Lower South; 13, the Swamp Region; 14, the Creole Country; 15, the River Country; 16, Canebrakes and Ozarks; 17, the Corn Belt; 18, the Wheat Belt; 19, Chicago; 20, Mackinac; 21, the Cattle Country; 22, the Mountain West; 23, the Arid West; 24, California and the Old West; 25 (not shown), Alaska; unnumbered stippled areas, neutral zones.

Jean Theraud as "ces nappes homogènes par le sol, le sous-sol, le mode de culture et de propriété, l'habitation et l'aspect particulier qu'y prend la vie des plantes, des animaux et des hommes." They are the popular divisions of the countryside, Argonne, Woëvre, Brie, Sologne, Limagne, etc., and their designations as employed by the peasants are often older than the names of the provinces of the *ancien régime* or of the medieval feudal territories. The selections in Monsieur Gorceix's pleasing book are arranged according to the major divisions of the country, and a map is provided showing these divisions and the various *pays*. The compiler introduces each section of the volume with a brief account of the principal geographical elements of the region under consideration and a bibliographic note on the outstanding geographical monographs. The book presents an admirable combination of scholarly treatment with genuinely subjective and colorful word painting, a form of combination in which the French are masters.

GEOGRAPHICAL NEWS

Geography at the British Association Meeting at Toronto. The ninety-fourth meeting of the British Association for the Advancement of Science was held at the University of Toronto from August 6 to August 13. In contrast to the American A. A. S., geography is represented by a separate section (E) in the British Association. This leads to a more strictly geographical program, geological topics being discussed in the geological section (C).

Twenty-three papers were read in the four morning and two afternoon sessions devoted to the program. The outstanding paper by reason of its truly geographical analysis of the problem was the one by Professor P. M. Roxby of the University of Liverpool on the Distribution of Population in China. Based on the census made in 1918 by the Survey Committee of China, a missionary organization, maps were shown which for the first time represent the essential facts of population distribution in China. This distribution was discussed in relation to the natural divisions of the country, and the regional outlook of the main nuclei of population was described. The probable rôle of the Lower Yangtze region, and especially the Hupeh Basin, in the political consolidation of the Chinese people was then pointed out, with a possible change of the capital from Peking to Hangchow or Nanking—a consolidation in which the great north-south railroad, when completed, will of course play an important part. Professor Roxby's paper will appear in full in a forthcoming number of the *Review*.

The presidential address, by Professor J. W. Gregory of the University of Glasgow, dealt with Inter-Racial Problems and White Colonization in the Tropics. After a survey of conditions in the different parts of the world where the white and colored races live together—in racial fusion in South America, in co-resident distinctness in the United States, in racial segregation as desired for South Africa—tropical colonization and the future of Australia were discussed.

Several other papers dealt with aspects of human geography. Miss Ellen C. Semple spoke on the Influence of Geographic Conditions on the Ancient Mediterranean Religions, pointing out how the importance of rainfall is reflected in the persistence of the worship of a rain-giving deity or saint. Dr. H. H. Laughlin of the Eugenics Record Office of the Carnegie Institution discussed Immigration from a Biological Point of View, with special reference to the policy of the United States. Mr. H. L. Seymour of Toronto, who has been associated with Mr. T. Adams, now of the Committee on the Plan of New York and Its Environs, read a paper on Some Problems of Urban Growth in America in which the principles of town planning were elucidated.

A group of papers provided a valuable survey of the contributions to the geography of Canada made by various Canadian government bureaus and other agencies. Mr. E. M. Dennis told of the Work of the Topographical Survey, Mr. W. H. Boyd of the Geological Survey's Part in the Topographical Survey, Mr. A. M. Narraway of the Practical Application of Aerial Photographs to Surveys in Canada, Mr. W. H. Herbert of the Work of the Magnetic Survey, a colleague of Mr. N. Ogilvie of the Work of the Geodetic Survey, and Dr. W. Bell Dawson of the Work of the Tidal Survey. An important development announced in these papers is the forthcoming unification of the mapping bureaus of the Canadian government. This will bring about the extension to easternmost Canada, for which the so-called Topographical Map, which does not show relief, has been the standard, of the type of mapping now carried on in the prairie provinces and in Old Ontario and Quebec and illustrated respectively by the excellent Sectional Map published by the Topographical Survey and the one-inch-to-the-mile map published by the Department of National Defense, both of which now represent relief in contours. Mr. D. W. McLachlan, engineer in charge of the St. Lawrence Ship Canal, spoke on the Pro-

posed Improvements of the St. Lawrence and Great Lakes System for Power and Navigation. Lake ports will be brought nearer to the markets of Europe by the improvements under way. Dr. R. M. Anderson read two papers resulting from his connection with the Canadian Arctic Expedition of 1913–1918. One described the scientific work of the Southern Party (with this topic readers of the *Geographical Review* are familiar: see Vol. 4, 1917, pp. 241–266); the other discussed the Present Status and Future Prospects of the Larger Mammals of Canada. In this connection mention should be made of a paper announced by Professor J. F. Unstead of Birkbeck College, London, not read on account of his absence through illness, on the Natural Resources and Economic Future of Canada. It was proposed to express the result of full utilization of the economic resources in each of the natural regions of the country in terms of the number of people who could be supported. This group of papers was supplemented by an exhibit illustrating the geographical activities of the Canadian government bureaus.

Several papers dealt with other regions or other aspects of regional geography. Mr. O. H. T. Rishbeth of the University of Southampton spoke on Some Geographical Consequences of the Geology of Australia, dwelling mainly on the fundamental problem of water supply. Mr. W. L. G. Joerg discussed Human-Use Versus Natural Regions, With Special Reference to North America. Mr. A. Stevens of the Department of Geography of the University of Glasgow gave an intimate picture of the hard life of the crofters on the Hebridean island of Lewis. Major C. Christy gave traveler's glimpses of conditions along the Cape to Cairo railway, 5000 of whose 7000 miles are in operation and along the route of which there remains only a 100-mile gap (between Nimule and Rejaf) without boat or rail communication.

Physical geography was represented by two papers and by a joint discussion with Section C on Changes of Sea Level in Relation to Glaciation, Continental Shelves, and Coral Islands in which Professors R. A. Daly, W. M. Davis, and A. P. Coleman took part. A paper illustrated with exceptional lantern slides was Dr. Vaughan Cornish's on Wind, Waves, and Swell on the North Atlantic. Professor W. H. Hobbs of the University of Michigan called attention to the fact that meteorologists in their descriptions of the circulation of the atmosphere do not seem to have taken sufficient account of the great anticyclones prevailing over the glacial ice caps of Greenland and the Antarctic Continent.

Three other papers completed the geographical program. Mr. John Bartholomew, head of the Edinburgh Geographical Institute, the well-known map publishers, spoke on Modern Developments in the Use and Construction of Maps. An item to which he made reference is of interest to all who are familiar with the inadequacy of the existing maps in this field, in that an up-to-date population density map of the British Isles is being prepared by a committee of British geographers. Mr. J. H. Reynolds described the Work of the Permanent Committee on Geographical Names for British Official Use. Dr. Marion I. Newbigin discussed the Training of the Geographer in Great Britain.

A number of papers presented before other sections were also of interest to geographers. Of these it seems unfortunate that, because of conflicting time schedules, the geographers were unable to hear the paper before Section L (Education) on the Teaching of the History and Geography of the British Empire by Professor G. M. Wrong of the University of Toronto, in view of Professor Wrong's sympathy with the geographic viewpoint in history. Before the same section Mr. Ernest Young spoke on Modern Tendencies in the Teaching of Geography. In Section A (Mathematical and Physical Science) meteorological topics were discussed by Sir Napier Shaw (If the Earth Went Dry) and Sir Frederic Stupart (The Variableness of Canadian Winters). Before Section D (Zoölogy) Professor A. G. Huntsman read a paper on the Circulation of Water off the Canadian Atlantic Coast. Dr. A. C. Haddon presented a suggested Arrangement of the Races of Man before Section H

(Anthropology). Before Section F (Economic Science and Statistics) Mr. G. Udny Yule discussed the Population Problem from the Standpoint of the Pearl and Reed Law of Growth, and Professor C. D. MacIver spoke on Civilization and Population. Before Section G (Engineering) and K (Botany) a number of papers were read dealing mainly with the economic resources of Canada: on the water powers, by Mr. J. B. Challies, Director of the Water-Power and Reclamation Service; on the Development of the St. Lawrence for Power and Navigation, by Mr. R. S. Lea; on Forest Utilization in Canada, by Mr. R. D. Craig; on the Problem of the World's Timber Supply, by Mr. Craig and Mr. F. Storey.

Several excursions were arranged for during and after the session. Of those under the auspices of Section C (Geology) a local excursion to study glacial phenomena in the Toronto district, mainly in the Don Valley and at Scarborough Heights, and an excursion to Niagara Falls and the Niagara Escarpment at Grimsby were generally attended by the geographers at the meeting. Excursions of geographical interest were also made by the Engineering Section in Toronto harbor and to the Welland Canal and the Queenston hydro-electric plant. But the most interesting of all was the transcontinental excursion across Canada after the meeting, August 17 to September 3. The route, which was traveled in two special trains, led to Vancouver by the Canadian National Railway and back to Toronto by the Canadian Pacific Railway. Technical guide books were issued: for the Niagara excursion, by Professor A. P. Coleman; for the transcontinental excursion, by Mr. James White. In addition a valuable handbook of Canada discussing the history, geography and economics of the country was issued, which forms a counterpart and addition, as it were, of the similar publication issued on the occasion of the previous meeting of the British Association in Toronto in 1897.

Professor Douglas Johnson's Exchange Professorship in France. During the academic year 1922–1923 American geographers had the pleasure of welcoming Professor Emmanuel de Margerie in his capacity as Exchange Professor in Engineering and Applied Science to the Universities of Harvard, Yale, Columbia, Cornell, Pennsylvania, Johns Hopkins, and the Massachusetts Institute of Technology. Last year (1923–1924) a return visit to France was made by an American geographer, Professor Douglas Johnson, representing the same institutions.

During the winter Professor Johnson visited the Sorbonne and the Universities of Dijon, Nancy, Rennes, Bordeaux, Montpellier, Algiers, Lille, Strasbourg, Clermont-Ferrand, Lyons, and Grenoble, delivering altogether more than seventy formal lectures as well as making many shorter speeches and holding various conferences with students, always in the French language. In each university he gave a number of lectures of general interest on such topics as American Rivers, Glacial Sculpture in America, the Atlantic Coast, and the Grand Canyon of the Colorado. In addition he gave a number of more technical lectures for the benefit of students chiefly or technical engineers, on such subjects as the Submarine Topography of the Gulf of Maine, Rectilinear Shore Lines of New England and Acadia, the Application of Physiography to Legal Problems. The conferences with the students were more informal talks in connection with the study of map interpretation, in which American maps were chiefly used. At the request of the French Army a special address was given before the officers of the Topographic Branch, French maps being used as a basis for the discussion.

At many of the universities interesting excursions were planned, the most extensive being a trip from Algiers, across the Atlas, into the Sahara to the present end of the railroad line at Tuggurt.

The University of Nancy awarded to Mr. Johnson the special medal of the university. The Geographical Society of Bordeaux made him an honorary member

of that organization, and the University of Grenoble conferred upon him the degree of Docteur *honoris causa.*

Certain of the lectures will be published at an early date under the title "Paysages Americains et Problèmes Géographiques."

Obituary

Mr. George Kennan, well known as an explorer, writer, and lecturer, died at Medina Depot, N. Y., on May 10 in his eightieth year. Mr. Kennan's most interesting geographical work arose from his connection with the project of an "overland" telegraph route between Europe and America via Bering Strait, an undertaking abandoned on the successful laying of the transatlantic cable. In 1865 he was sent to Siberia to engage in reconnaissance work over a part of the proposed route. His surveys included the previously unexplored region between the Gulf of Gizhiga (on the Okhotsk Sea) and the Anadyr River. The narrative of the expedition is told in "Tent Life in Siberia" (1870; revised edit., 1910). In 1870–1871 Mr. Kennan explored the eastern Caucasus. In 1885–1886 he investigated the Russian exile system, publishing his findings in a two-volume work "Siberia and the Exile System" (1891). Among his later writings mention may be made of his graphic account "The Tragedy of Pelée" (1902).

Mr. Kennan was a Life Fellow of the American Geographical Society and a contributor to the earlier volumes of the Society's *Journal.* His sustained interest in the Society is manifested in the bequest to the institution of his large collection of lantern slides.

GEOGRAPHICAL REVIEWS

Two Works on Political Geography

Alexander Supan. **Leitlinien der allgemeinen politischen Geographie: Naturlehre des Staates.** 2nd edit., edited by Erich Obst. viii and 199 pp.; maps, diagrs., ill., index. Vereinigung wissenschaftlicher Verleger, Walter de Gruyter & Co., Berlin and Leipzig, 1922.

In Supan's great work on the population of the earth the method was rigidly statistical. The second stage of his development was marked by the production of two books, "Grundzüge der Physischen Erdkunde" and "Die Territoriale Entwicklung der Europäischen Kolonien," in which the same quality appears in high degree. There are also exhibited the rigid tests and masterly restraints that we expect to find in a truly scientific production by a mature scholar. His last work (published posthumously) was in the field of political geography, and here there was freer play for the imagination and especially for opinion, and, we regret to add, for prejudice. The times had changed: he stood on the threshold of the new, or post-war, world as a German and saw wreckage everywhere. The despair that he felt is conveyed to these pages, and it is but just to his memory and to his earlier work that the basis of it be remembered when reading some of the strictures that follow.

The trouble with Supan's philosophy lies in his almost instinctive search for a "system" wherein should be rationalized the facts comprised in political geography. It is as if he searched for laws akin to those that govern the physical world. It is characteristic of the German school of political geography that its logic so often rests upon mere classification, and the descent is not far from this to *obiter dicta* and the worship of ritual and mummery. There is much that is excellent in Supan's book, and to this we shall presently give full credit. Here, the point of emphasis is the spirit and logic of the work as a whole. The worst example of the illogical is in the first paragraph of the first page: institutions are the means of achieving civilization; the state furnishes the means of existence of such institutions; the state is the foundation of civilization or culture; one cannot think highly enough of the state. The alternative to this policy is individualism whose baneful effects he finds illustrated in communistic Russia. Such an eye is too largely filled with European, i. e. near-by, examples. Such a philosophy seeks to draw out leviathan with a hook. With that history those things may be expected, but what of the fresh examples overseas? A large part of the world is politically in the pioneering stage; its philosophy is certainly more individualistic and democratic; is it so near the abyss as Europe today? When Supan turns scientist his thought is always illuminating; witness especially his distinction between the active and passive spaces and his emphasis upon the necessity of comparing active with active when we compare two nations, otherwise we do not apply the proper shrinkage, for example to northern Canada and Russian Siberia. He rightly criticizes Ratzel's overemphasis of space alone whereas it is people, nations, societies, and cultures that give space its chief geographical significance. He draws a startlingly clear picture of the flowing, not the static, life of boundaries. Even if by some process of necromancy boundaries were adjusted on all frontiers to national needs and if proper economic advantages and political scope were given to every nation, the equilibrium would last but for a moment, just as in the case of an equal distribution of wealth among a whole population. Birth rates differ, industries and natural resources differ, vital energy and initiative differ. Inequalities arise from these and other causes, and strife and shifting boundaries once more occur. There is virtue in the argument of "organic bound-

aries" and the philosophy of *Lebensraum*, but they are open to abuse like the arguments based on history and military necessity of which much use was sought to be made at the Paris Conference of 1919. Curzon's argument regarding the protection of the Indian frontiers is the inevitable one employed in advocating "natural frontiers" and in following a purely territorial policy as opposed to a national policy. It is the large states, curiously enough, that require the most elbow room and seek most aggressively for increase of space and power often to the point of weakening the central state and government. In all times, large and small states have existed on account of differences in topographic layout, resources, stages of development, and the like. The sea and the desert give geographical position its greatest force and meaning, while mountains were early reduced in importance on account of the passes at the heads of deep valleys, though they still exercise a measurable and often a strong political influence, as is shown in the case of Tibet.

The historical rôle of great cities is discussed together with their function as political centers and even as states before land and territory had political value. What a far cry is this from the condition of the world today, when even the empty spaces are no longer non-political. Great Britain in Antarctica, France in the Sahara, and all great powers with respect to the sea, illustrate the generalization. Nonpolitical areas are all but nonexistent. Border belts have thinned to line boundaries. Neutral zones, like that between Norway and Sweden, have almost disappeared.

Such are a few of the objective and impersonal illustrations from political geography in which the text abounds. Interspersed are many examples of the philosophy to which we referred at the beginning. The author disparages Woodrow Wilson among other things for being led astray by pseudo-nationality as illustrated by Czechoslovakia; but who should absorb the Czechs if there were no Czechoslovakia he does not say. Is it only "pseudo" when Germans are absorbed? The so-called "colonial quotient" (pp. 22–23) appears to be a barren basis of argument to all but a Germany bereft of her colonies. "The Englishman regards himself as the divinely appointed Lord of the Earth," is a sentence which an American scholar might speak in an unguarded moment, but he would hardly write it. The same is true of the reiterated charge that France is "atheistic" and "sterile." Self-determination fits Supan's idea of the state as at once the mother and protector of all culture; and it is a solace for a Germany shorn of territory, east and west, that is peopled by Germans. Would it have been a part of his "system" if German arms had extended their sway to the outer marches? Pan-Slavism, Pan-Germanism, Pan-Turkism, and Pan-Islamism have all gone their way, and he thinks they are an illusion but that connationality has possibilities. Asia for the Asiatics and Africa for the Africans is a policy he approves, but in Europe it is quite different; and the book ends on a bitter note that refers particularly to the loss of the German colonies as a violation of any possible economic system. He inquires meaningly, Cannot Slavs and Germans unite as a counterpoise to Anglo-Saxons, Latins, and Japanese?

FRIEDRICH RATZEL. **Politische Geographie.** 3rd edit., revised and enlarged by Eugen Oberhummer. xv and 626 pp.; maps, indexes. R. Oldenbourg, Munich and Berlin, 1923. $3.50. 10 x 7 inches.

Where the old political geography was constituted by an unorganized assemblage of statistical facts Ratzel made a scientific inquiry into the relations existing between land and state, or between geography and national policy. A quarter of a century since its first publication (1897) there appears the third edition of Ratzel's pioneer effort to lift political geography to the rank of a science. His work starts from a geographical conception of the state, "because the state, in all its stages of political evolution, maintains a constant and necessary connection with its land." This national territory has geographical location, area, and climate; it embraces a group of

natural features; it is delimited by boundaries drawn on the earth's surface; and it sustains definite relations with its political neighbors. To this complex of geographic conditions the state adjusts itself in the course of its development, exploiting its natural advantages to build up political power and to overcome the handicaps of its environment.

The study of this land-rooted state requires the "geographical sense" which has always characterized practical statesmen, like Disraeli and Thomas Jefferson, and which has distinguished whole nations, like the British. In such it is called politico-economic foresight, political instinct, or imperialistic policy; but at bottom it means a correct estimate of the geographic basis of national power, an eye for the main geographic chance. This "geographical sense" contributes to the evaluation of political policies and the understanding of many historical events. Ratzel formulated guiding principles and reduced them to a scientific system. His "Political Geography," therefore, was such as to make a strong appeal to statesmen and historians as well as to geographers. Such an appeal it did make, significantly enough, to the practical English, who might well have adopted it as the Bible of their foreign policy. In Germany it was more appreciated by students of political science than by the geographers; for these, committed to physical, economic, and commercial geography as the orthodox branches of their subject, frowned upon the new science as nonconformist. Hence for some twenty years it stimulated little or no effort among German geographers to till the promising field. Then the World War came and by its cataclysmic forces thrust into prominence innumerable concrete problems of political geography, which set up a new demand for scientific political geography. Geographers like Hettner, Supan, and Schlüter reversed their previous positions and welcomed the subject into the inmost circle of the scientific geography. In 1918 appeared the first edition of Supan's "Leitlinien der allgemeinen politischen Geographie," with a preface assigning to political geography a new importance in order to counterbalance the preponderant development of geography on the physiographic side. Articles and treatises by Partsch, Karl Dove, Hettner, Schlüter, Walter Vogel, Dix, Sieger, and Kjellén, the latter a follower of Ratzel, appeared in rapid succession.

The new edition of Ratzel's work is a response to the new demand. Some redundant material has been eliminated from the original copy in the present volume, which is enriched, moreover, by a scholarly historical sketch of political geography by the editor. In a footnote Professor Oberhummer expresses his regret that he has been unable to include in the sketch the recent foreign contributions to the subject, because he did not have access to the books.

Ellen Churchill Semple

Geography and Nationalities

Arnold Van Gennep. **Traité comparatif des nationalités.** Vol. 1, **Les éléments extérieurs de la nationalité.** 228 pp.; index. Payot & Co., Paris, 1922. 8 fr. 9 x 6 inches.

The problem of nationality and of nationalism, or the aggressive manifestation of the spirit of nationality, is one in regard to which there has been an infinite amount of vague thinking and loose writing. The book under review gives satisfaction because it is based upon the observation and comparison of facts rather than upon prejudice, sentiment, and abstract theory. The author proceeds inductively: through the systematic examination of the various elements and expressions of nationality he would arrive at some generalizations regarding its nature and the manner in which it may be guided into channels conducive only to the good of humanity. In the present volume he deals with the "external symbols" of nationality; the second and third will be devoted to a far more difficult subject, "the in-

ternal elements and factors of nationality" and "the general laws which govern its birth and control its evolution." Let us hope that the conclusion of the work will measure up to the first part in scholarship and logical clarity of presentation!

The problem of nationality is often thought of as exclusively one of history, or of political theory, or of mass psychology. Van Gennep recognizes the immense importance of the geographical factor, and his footnote references show that he is thoroughly versed in recent geographical thought upon the subject.

Among the external symbols of nationality some are temporary and accidental, changing with time and custom as, for instance, a characteristic style of tattoo or costume, of flag or alphabet, of house form or village plan. More significant, however, are the semi-permanent symbols: language and territory.

Language is often, though not invariably, a criterion for the determination of nationality. The recent history of Central and Eastern Europe shows the lengths to which nationalism may go in an effort to suppress a language symbolic of an alien and potentially hostile nationality. Very illuminating is Van Gennep's discussion of official methods of perverting and misinterpreting linguistic and other statistics.

The most nearly permanent as well as the most impressive of all the symbols of a nationality is the territory it occupies. This territory is, of course, not necessarily the same as the territory of a political state or of a linguistic area. "In order that a given territory may fully acquire its symbolic value, one should know where it ends." In other words, the problems of the "nationalitary frontiers"—to use a neatly coined adjective employed by Van Gennep—and of their relations to linguistic, political, economic, strategic, and natural frontiers are of major importance in the study of nationalities. They are essentially geographical problems.

Particularly interesting in view of the theoretical nature of many geographical studies of these matters are Van Gennep's observations on so-called "natural frontiers." How far can it be asserted that the various types of human frontier actually correspond to such natural features as the crest lines of mountains, water partings, or rivers? Is there a general law indicating that they tend so to correspond? The author answers both of these questions in the negative. Detailed and critical examination of the facts seems to show that only in exceptional cases do such coincidences occur. A great river tends rather to unite than to separate the people dwelling on either side, and a great mountain range from the point of view of nationality and language may be regarded as a "dorsal spine" rather than as a barrier. The theorists who seek a direct, necessary, causal relation between the areas occupied by nationalities or language groups on the one hand and natural regions on the other confuse "two series of facts essentially independent."

A French Series on "The Evolution of Humanity"

Edmond Perrier. **La terre avant l'histoire: Les origines de la vie et de l'homme.** xxviii and 414 pp.; maps, bibliogr., index. (L'Évolution de l'Humanité, Vol. I.) La Renaissance du Livre, Paris, 1920. 15 fr. 8 x 6 inches.

Jacques de Morgan. **L'Humanité préhistorique: Esquisse de préhistoire générale.** xix and 330 pp.; maps, ills., bibliogr., index. (L'Évolution de l'Humanité, Vol. 2.) La Renaissance du Livre, Paris, 1921. 15 fr. 8 x 6 inches.

L'Évolution de l'Humanité is the title of an interesting series which hopes, in 26 or more volumes, to give its readers a sketch of evolution and principally of human and social evolution. The printing and paper are the simplest and cheapest so that the price may be as low as possible. It is felt that the discussion of evolution is closed and the idea definitively established and that one may venture upon a kaleidoscopic review in preparation for further discussion of the steps and the

processes of evolution. The first volume of the series bears the great name of the Professor of Comparative Anatomy at the Natural History Museum at Paris. It attempts a sketch of evolution up to the appearance of man, and the biological reader will follow with great interest and frequent agreement the thoughts of the famous author about different groups of animals and plants. At the same time he may well regret that the attempt was made to compress all into one volume and that the opportunity was not taken to get some one like M. de Margerie to write of the evolution of the earth and the succession of floras and faunas in their relation to earth changes. Those who know de Margerie's version of Suess will feel that a summing up by him might have illuminated many points perforce left vague or unnoticed. The discussion of the history of climate, again, is not of great value and, as the manuscript was largely written in 1914, does not take into account the contributions either of C. E. P. Brooks or of Huntington to this difficult but most fascinating subject. On the other hand, the wide and ripe knowledge of forms of life that Perrier has amassed is here utilized to give a sketch that, with occasional references to some standard biological textbook, may become valuable and illuminating even to the non-specialist.

The general succession of ideas in the book starts with a very short notice of the birth of the earth and the transformations of land masses and attendant climatic changes. Then it surveys early forms of life and the plans on which organisms are built. In concluding this section the author notes the fragmentary nature of the life of continents, abysses, and open seas and the large proportion of that life which shows high specialization and which seems to belong to fairly recent types, leaving the reader to infer the importance of the shore zone as a home of early life and the spread of forms of life from it in all directions. The second section surveys life in the Paleozoic, Mesozoic, and Cainozoic periods and sketches very briefly the origins of man. Many of the opinions expressed are open to dispute, but that type of dispute would concern more especially the zoölogist. In spite, however, of points here and there which are either disputable or left hazy, the reader will admit that Perrier has executed a *tour de force* and will enjoy this work.

De Morgan's volume, the second in this series, shows a better proportion of its parts than do some other books on prehistory for, in the first and chronological section the Old Stone Age is not given much more space than the subsequent periods (Neolithic, Bronze, and Early Iron Ages) down to the opening of historic time. The second section discusses dwellings, the food quest, clothing, and ornament. The third deals with the intellectual development and interrelations of peoples.

The book has considerable interest as being the work of one who has been dealing with prehistoric problems for many years; but it could hardly be expected to be fully up to date, and one notices many cases of omission or imperfect use of authorities. The study of prehistoric times is now developing so fast and in so many countries that it is difficult for even the most active mind to keep pace with results.

The table showing the relation of our hypothetical Paleolithic "periods" to phases of the Ice Age given by de Morgan is based on that published by Boule in 1906, since when much has been worked out as readers of *Man* for 1921–1923 will know. The maps of distributions of Paleolithic cultures are open to discussion in some points, while in others the difficulty and the disparities between de Morgan and other authorities arise from uncertainties which warn us that even the accepted classifications may be modified. The Neolithic Period would need a fresh treatment following on the work of Ischer and of Åberg, not to mention others, while the Bronze Age is being considered anew, thanks to the vast catalogue of Bronze Finds compiled for Great Britain in recent years under the direction of H. J. Peake and now in the library of the Society of Antiquaries of London. The volume, in fact, stands as a closing chapter of the earlier period of thought. Needless to say, there are many illuminating remarks and suggestions scattered through it;

and it may serve as a useful jumping-off ground for a student who wants to proceed next to the mastery of current controversies in this rapidly changing sphere of thought and research.

H. J. Fleure

The Pyrenees and Cantabrian Mountains

M. Sorre. **Les Pyrénées.** 216 pp.; maps, diagrs., ills., bibliogr., glossary. (Collection Armand Colin, No. 15.) Librairie Armand Colin, Paris, 1922. 5 frs. 7 x 4½ inches.

F. Schrader. **Massif de Gavarnie et du Mont Perdu.** 1:20,000. Henry Barrère, Paris, 1914.

Ludovic Gaurier. **Études glaciaires dans les Pyrénées françaises et espagnoles de 1900 à 1909.** With a preface by Charles Rabot. xvi and 363 pp.; map, diagr., ills. Pau, 1921. 9¾ x 6¼ inches.

Pedro Pidal and J. F. Zabala. **Picos de Europa: Contribución al estudio de las montañas españolas.** 120 pp.; maps, ills., index. Club Alpino Español, Madrid, 1918. 11 x 8 inches.

A. d'A. de Saint-Saud. **Monographie des Picos de Europa (Pyrénées Cantabriques et Asturiennes).** With a Preface by F. Schrader. xiii and 271 pp.; map, diagr., ills., index. Accompanied by portfolio of four maps by L. Maury. Henry Barrère, Paris, 1922. Text 10 x 6½ inches, portfolio 11½ x 8¼ inches.

M. Sorre's well balanced and picturesquely phrased little regional study of the Pyrenees represents the best traditions of the modern French school of geography. It comprises three parts: the first gives a general view of the Pyrenees as a whole; the second a detailed account of the different regions into which they may be divided; and the third a brief discussion of their natural resources. The volume is a scholarly popularization of a type which the French show true genius in producing.

Although neither as lofty nor as extensive as the Alps, the Pyrenees may nevertheless be regarded as a mountain region of the first order on the basis of other elements than topography. The climate, for instance, though modified by the narrowness of the range and by the equalizing breath of the ocean, reveals such phenomena as the pronounced local inversions of temperature and the well-developed valley breezes associated only with high mountains. The Pyrenees are also sufficiently high and well-defined to mark a climatic frontier between the dry plateaus of northern Spain and the rainy plains of southeastern France. There are likewise striking differences between the moist western valleys on the French side and the warmer, drier pockets of Roussillon and Cerdagne where Mediterranean influences prevail. From the human point of view local climates, soils, and topography are sufficiently varied to have given rise to some of those conditions of life typical only of truly Alpine environments: "ces déplacements périodiques, ce rythme saisonnier de la vie qualifié parfois de nomadisme non sans abus de langage, et l'autonomie des vallées et l'émigration."

The uplifted eastern half of the Pyrenees was maturely eroded during a former cycle of erosion before the uplift took place. It now presents smoothly sweeping slopes into which the streams of the present cycle are vigorously cutting young valleys. To the west the present cycle has progressed far enough to wear away most of the older surfaces, leaving bold and rugged summits. Glacial action has also contributed to the roughening of the topography. The famous Cirque de Gavarnie, at the headwaters of the Gave de Pau, is an impressive amphitheater, scooped out in the past by vastly larger glaciers than those now clinging to its walls. Schrader's

striking map represents graphically the contrast between the cliffs of the cirque and the smooth, mature slopes out of which the cirque has been cut.

Compared with the glaciers of the Alps the existing glaciers of the Pyrenees are insignificant. Altogether they occupy barely more than 25 square kilometers—an area, as M. Charles Rabot explains in his preface to M. Gaurier's book—about equivalent to that of a single Alpine glacier of average size. These glaciers, nevertheless, are important in that they serve as sensitive indices of climatic change. The water supply which they and the melting snows of the mountains give forth in the summer determines to a large extent the agricultural and industrial destinies of the Pyrenean valleys. M. Gaurier's monograph, when complete, will be a detailed study of the glaciers past and present and of the hydrography of the Central Pyrenees. The present volume, devoted to glaciers, lakes, streams, and snowfall of the valleys contributory to the Gave de Pau and to the hydrography of the Gave d'Ossau, is of great value by reason of the wealth of careful and minute observations of which it forms the record.

The Picos de Europa are the highest, wildest crags of the Cantabrian mountains, topographically, at least, the westward continuation of the Pyrenees in northern Spain. Though the loftiest summit does not rise above 2639 meters (8658 feet), the massif is Alpine in the rugged character of its crests and in the presence of snow fields and small glaciers. Sometimes not altogether aptly it has been styled the Dolomites of Spain. The two volumes listed above which deal with these mountains are the work of mountaineering enthusiasts; enthusiasts, however, with pronounced scientific interests, who have incorporated into their books, besides the narratives of ascents, observations of no little value on topography, geology, climate, and people.

Lieutenant Maury's maps of the Picos de Europa, which accompany the Comte de St. Saud's volumes, have been drawn in the spirit of scientific cartography; regions not actually observed are left blank. These maps, together with Schrader's "Gavarnie," are unusually valuable contributions to the documentary material available for the study of the comparative physiography of high mountains.

Travel Notes in Italian Somaliland

Giuseppe Stefanini. **In Somalia: Note e impressioni di viaggio.** 343 pp.; map, ills. Felice Le Monnier, Florence, 1922. 9½ x 6½ inches. 45 lire.

This volume presents a semipopular record of a tour undertaken in 1913 under the auspices of the Government of Italian Somaliland, primarily for a study of its subterranean water sources and to obtain some knowledge of the geology and mineralogy of the colony. The political capital, Mogadishu, founded about 900 A. D., and most flourishing under the M'doffer dynasty (1200–1600), is described at some length with an outline of its history; but its ancient mosques, which would well deserve consideration, are dismissed with tantalizing brevity—a statement which, unfortunately, also holds true for the account of the Mohammedan ruins at Amarr Gegeb, about five kilometers to the southwest. Merka, the agricultural center, and Barava, the chief commercial port—both ancient towns—are likewise described; but the account of Bardera seems, except as a picture of a large Somali village, a little disproportionate, particularly as it is scarcely likely to become of either commercial or industrial importance, while its present political and military value may prove evanescent. Pre-Somali remains, in the form of stone walls, are found at Isha Baidoa, as well as at Uambatti and El Dem; but, unfortunately, no photographs are given, though at least one would have been very welcome to the archeologist.

In view of our somewhat scanty knowledge of the geography of Italian Somaliland, particular interest attaches to the author's study of the Webi Shebeli, which for some 300 kilometers runs closely parallel to the coast, being only 14 kilometers from the sea at Merka, and which, further south, seems to disappear, emptying neither into the ocean nor into another river. It is possible that the marshes where the Shebeli vanishes may possess some outlet which conducts the spate waters of the stream to the Juba, though this remains to be found; and the peculiar course of the river appears to have been caused by the formation of coastal dunes. Similarly the Juba, until 1909, was parallel to the sea and only a few meters distant from it for over three kilometers; but suddenly it broke through the barrier and formed a new mouth, the old one gradually silting up. The entire fourth chapter is devoted to a description of the course of the Juba.

The interesting problem of place names receives further illustration from the toponymy of Somaliland, where the great majority of appellations are derived from animals, vegetation, or soil, as "Red Ox," "High Palm," "Place of Stones."

The ethnology of the Somali is briefly considered. The aboriginal, agricultural negroes were conquered by three waves of pastoral Somali, moving from north to south; and there are likewise mixed breeds, who form distinct tribes. The dwellings are likewise of three types. Note is also made of trees marked with tribal signs whose complete elucidation has not yet been made.

The author is able to give only scanty hopes of important mineral resources in Italian Somaliland. On the other hand, a railway might prove of economic value. Two lines have been suggested: one coastal and the other interior. The former, with its center at Barava, which might at great expense be made a port to serve at all times of year, would not tap the *retroterra*, whose trade is gradually being absorbed by the French to the north and by the British to the south. The second line, in the author's opinion, would be far preferable as tapping the Baidoa (the natural route to the Galla country and to the Shoa); and it should extend to Logh or, better still, to Dolo.

Finally, as regards cartography, it should be observed that existing maps of this region are quite unreliable; but the Istituto Geografico Militare is engaged in making a map on the scale of 1 : 50,000.

Louis H. Gray

Miscellanies of Travel Memories

G. N. Curzon. **Tales of Travel.** 405 pp.; map, ills., index. George H. Doran Co., New York, 1923. $7.50. 9½ x 6½ inches.

D. W. Freshfield. **Below the Snow Line.** viii and 270 pp.; maps, index. Constable & Co., Ltd., London, Bombay, Sydney, 1923. 18s. 9 x 6 inches.

Lord Curzon's volume consists of miscellaneous essays on a broad range of topics. Many of these deal with experiences drawn from journeyings on errands of pleasure or diplomacy in nearly all parts of the world. Most absorbing is the account of a visit in 1894 to the Amir of Afghanistan, Abdur Rahman Khan, a medieval despot of a type the Orient occasionally produces even in modern times, a "strange and almost incredible amalgam of the jester and the cynic, the statesman and the savage," in whom "a passion for cruelty was one of his most inveterate instincts." A map accompanied by a proclamation issued by the Amir and used to arouse the patriotism of his subjects is reproduced by Lord Curzon and will well repay examination by those interested in cartographic eccentricities. Other chapters in "Tales of Travel" tell of journeys to Kairwan and to the falls of the Zambesi and discuss the wrestling contests of Japan. Chapters entitled "Pages from a Diary" and

"Humours of Travel" consist of brief vignettes of characteristic, impressive, or amusing episodes. Three essays, on the other hand, are the results of somewhat extended research into matters which made an especial appeal to the author's imagination. These deal with the sounds which many classical writers describe as having issued from one of the Colossi of Egyptian Thebes, with the great waterfalls of the world, and with singing sands. In the chapter on the last-named topic, Lord Curzon summarizes and subjects to criticism various theories that have been propounded in regard to the mysterious sounds produced by accumulations of sand in some places, sounds that have given rise to stories of goblins and evil spirits and in recent times have puzzled more scientific travelers.

Douglas Freshfield's restful volume, "Below the Snow Line," is akin to Lord Curzon's book in that it too is a miscellany of memories of a lifetime of travel. It differs, however, from "Tales of Travel" in one essential respect. Whereas Lord Curzon roams from the witnessing of barbaric ceremonials at Kairwan to the palace of Kabul, from bullfights to reminiscences of Chinese diplomats, from waterfalls to sonorous sands, Mr. Freshfield's interest is concentrated on mountains. His interest in mountains, however, is by no means a narrow one. He does not confine himself, as is too often the case with mountaineers, to the chronicle of adventures among rocks and ice. Indeed Mr. Freshfield is guilty of the heretical statement that "there are times when nothing but rock and snow becomes monotonous." "Below the Snow Line" is a record of wanderings among the foothills and lower ranges of the Alps, among the Apennines and mountains of Corsica, Greece, Algeria, and Japan. "Below the snow line" usually means, as well, "below the upper limit of vegetation" and often "below the upper limit of human enterprise." After all, mountains within these zones, if not as sublime as the mightier summits, are more varied, more individualistic, and generally more interesting from the geographical point of view. Mr. Freshfield always traveled with the curiosity of the scholar and the eye of the poet. There is enough history and natural science in his essays to give them background and substantiality but not too much to weary the "general reader." There is enough skill in the use of words to give color. To quote but one phrase, descriptive of a view in the Apennines at sunset: "Far away southward the snows on the huge bulk of the Majella glowed like a burning coal through the tremulous waves of blue air."

The Geographical Factor in the Early History of Alabama

T. P. Abernethy. **The Formative Period in Alabama, 1815–1828.** 192 pp.; maps, diagrs., ills., bibliogr. *Alabama State Dept. of Archives and History, Hist. and Patriotic Ser., Publ. No. 6.* Montgomery, Ala., 1922.

In the westward advance of our frontier and in the development of the frontier communities into established states geographical conditions played an important part. This fact has been recognized by many of our historians, but none has had a clearer perception of its significance nor has done more to guide students toward the geographical point of view in their historical work than Professor F. J. Turner of Harvard. Dr. Abernethy was one of Professor Turner's students, and the book under review was prepared as a doctoral dissertation under Professor Turner's direction. The volume deals not only with political events in the early history of Alabama but with the settlement of the region and with its agricultural, commercial, and social conditions at a critical time. The geographical factor throughout is given due consideration.

The location and composition of the first settlements in Alabama were determined partly by physiographic circumstances—as revealed more especially in conditions of soils—and partly by the routes from the older communities to the

north and east. The bottom lands of the Tennessee, Alabama, Tombigbee, and Black Warrior Rivers formed the richest agricultural districts of the state and were admirably adapted to the cultivation of cotton. These lands were early occupied by capitalist planters with their numerous slaves. The relatively less productive hilly country was left to farmers with little capital and few slaves. Most of the eastern part of the state was still in the hands of the Creek Indians until 1836. As regards its origins the population was likewise divided. The Tennessee valley and northern counties were peopled mainly by immigrants from Tennessee. The north-central hilly country and the valleys of the Tombigbee and Black Warrior were settled predominantly from the piedmont belt of the Carolinas and Virginia. Planters from Georgia occupied the valley of the Alabama, and Georgian farmers settled in the poorer southeastern counties.

The commercial, social, and political life of the state was influenced to no small degree by the circumstances of its settlement. Owing to the extreme difficulties of communication almost complete commercial separation prevailed between the north and south. Socially, the planters formed a world of their own and had few dealings with the small farmers. Political cleavage soon manifested itself between the latter, mainly of Tennessee origin, and the capitalistic planters who had come in large part from Georgia. Though the state went for Jackson in 1824, it is notable that the largest percentages of votes for the more conservative Adams were polled in the counties where the slave population was the greatest. These and many other points of similar geographical interest are ably discussed by Dr. Abernethy.

County Boundaries of California

Owen C. Coy. **The Genesis of California Counties.** vii and 92 pp.; maps, index. California Historical Survey Commission, Berkeley, 1923. 9 x 6 inches.

Owen C. Coy. **California County Boundaries: A Study of the Division of the State into Counties and the Subsequent Changes in Their Boundaries.** vii and 335 pp.; maps, index. California Historical Survey Commission, Berkeley, 1923. 9 x 6 inches.

At the present time California is divided into 58 counties, more than twice the number (27) first established by an act of the legislature in 1850. Some understanding of the intricate history of the subdivision of the old counties and of the frequent readjustments in their boundaries is essential for all who would undertake studies in the regional geography of the state. Dr. Coy explains in the prefaces to these volumes that in California "statistics are almost invariably given in terms of counties, and the county is the important unit in the state hierarchy. Studies of politics, of production, of population, resources and social developments must make use of county archives. But documents can not be located in the county archives, and can not be historically interpreted, unless it is known under what county jurisdiction they were made and filed and of what territory and social components they treat." The *raison d'être* of the two books under review is to provide a "key to the interpretation of records and figures otherwise difficult of access."

The first-named book was issued as a preliminary to the second, and all the data included in it form Part I of the second. It is a compact historical sketch of the genesis and evolution of California counties illustrated with maps showing the counties at eight different periods. There is also included a general key map of the whole state, by the aid of which one may quickly determine the various counties to which any given part of the state has belonged with the appropriate dates. The second part of "California County Boundaries" consists of a detailed, alphabetically arranged treatment of the changes in the limits of the various counties. A detailed

map is given for each county. The maps are admirably adapted to the presentation of a very complex mass of material, and the text is lucidly written.

Besides being of practical aid to further research, Dr. Coy's work is in itself a valuable contribution toward our understanding of an important phase of the historical and political geography of California. The progress of settlement is reflected in the number and size of the counties. The earliest Spanish and American settlements in California lay in the vicinity of San Francisco Bay and along the coast to the south, in the Sacramento Valley, and in the mining camps of the Sierras north of the Tuolumne River. As shown on the maps of 1850 and 1852 these parts of the state were already at that time divided into numerous counties of relatively small extent. Four large counties, on the other hand, made up the almost unsettled northern and southern extremities and the south-central interior back of the coast range. With the influx of population during the next fifty years and with its dissemination over the entire area of the state, all the larger and many of the smaller original counties were split up, though a fan-shaped group of comparatively small counties radiating from San Francisco Bay back into the Sierras is still apparent on the map for 1922. Imperial, the last of the counties to be organized (1907), was a result of the conversion through irrigation of the Imperial Valley from a desert into a prosperous fruit-raising district.

The vigorous expansion of Californian settlement led in 1852 to a somewhat surprising result, for in that year the legislature passed an act establishing Pautah county entirely outside the boundaries of the state! This act was repealed in 1859. "Many settlers from California and others bound for California had taken up their abode in the valleys of the Truckee, Carson, and Walker Rivers" in what was then the territory of Utah (now part of Nevada). This district was "near the mining region of California and being on the routes of the overland trail had much in common with this state." In 1860 further settlements in the same vicinity led to agitation that took the "form of a joint resolution asking Congress to cede to California" all that part of the present state of Nevada lying west of the 118th Greenwich meridian.

In general the influx of settlers has led to the creation of new counties. One case, however, is recorded where the unstable conditions of a frontier mining community produced the elimination of a county. Klamath, established in 1851, though originally large in territory was progressively reduced in size by annexations to its neighbors "until there was but little left besides rugged mountains whose diminishing wealth formed the main support of its population." As an indirect result of this situation the county was dissolved in 1874, and parts of it were joined to Humboldt and Siskiyou.

Manufactures in the United States

A Graphic Analysis of the Census of Manufactures of the United States, 1849 to 1919. 253 pp.; maps, diagrs. National Industrial Conference Board, New York, 1923. 11 x 9 inches.

This splendidly printed volume, containing one hundred and twenty full page colored charts and an equal number of opposing pages of statistical tables and explanatory text, presents some of the outstanding and essential facts relative to the development and present status of manufacturing in the United States. This vast fund of information is derived from the census reports of the United States, covering the period of its history from 1849 to 1919. Owing to the fact that this body of material has not been utilized to the fullest extent by those most likely to profit from it, the National Industrial Conference Board has undertaken in this volume to analyze and present in a concise, simple, and attractive form the princi-

pal facts relative to industrial conditions in the United States collected by the censuses during the past seventy years.

To the geographer this volume is highly interesting and suggestive. The first one hundred charts and statistical tables relate especially to the economic phases of manufacturing and have to do with such subjects as the number of persons engaged in various industries at different periods, the distribution of the personnel, the value of the products, the major items of expenditure in the different industries, the size of establishments, the character of ownership, the regularity of employment and the prevailing hours of labor, the power and fuel used, and the relation between production, labor, power, and values at different times during the period covered. Occasionally where some of these facts are expressed graphically upon maps of the United States a distinct geographical flavor is imparted to the subject. No explanations are made, however, in the brief space available for text. In most instances an acquaintance with the physical background and other geographical factors in the United States enables the reader to throw much meaning into the charts which otherwise would have only the virtue of presenting vividly some striking facts. Needless to say, much material not usually brought to the geographer's notice thus engages his attention.

The last twenty charts and tables, presenting the status of fifty leading industries in the United States, are especially interesting to one searching for geographic relationships and responses. In each case the extent of the industry is shown by states for the year 1919 and in many cases for the year 1879 as well. It is easy to see at a glance, therefore, the part played by each state and, where the maps for the two years are given, to note also what changes have taken place in the location of the different industries during the past forty years. All of this is of great geographical interest, especially if studied in the light of a clearly understood geographic background. Students of geography would be well repaid for the time spent in examining these charts and in attempting to explain the facts which they so strikingly and beautifully present.

A. K. Lobeck

A Reference Work on World Geography

Martin Vahl and Gudmund Hatt. **Jorden og Menneskelivet: Geografisk Haandbog.** Vol. 1, 572 pp.; maps, diagrs., ills., bibliogr.; Vol. 2, 434 pp.; maps, ills., bibliogr. J. H. Schultz, Copenhagen, 1922, 1923. 10 x 7 inches.

The preparation of this rather exhaustive treatise on general and regional geography was undertaken, according to the author's preface, because of the recognized lack of a scientific reference geography (in Danish). The authors speak of this as a "Haandbog," literally translated as Handbook but much more accurately stated in English as a Reference Geography.

The work when completed is to consist of four volumes with the following contents: Volume 1, General Geography, the Arctic Ocean, and North America; Volume 2, South America, Antarctica, Australia, and the Atlantic, Pacific, and Indian Oceans; Volume 3, Africa and Asia; Volume 4, Europe. There is also to be included a comprehensive catalogue of geographic names.

In Volume 1 the first 118 pages are devoted to a discussion of General Geography. This comprises what American students are beginning to designate "Principles of Geography." A brief summary of essential physical features is presented with no great departure from traditional types of treatment. Most American authors would be inclined to go into more detail than is here done in a work of this size. The summary is followed by a carefully organized discussion of zones of climate and vegetation. The controlling causes of these zones and their resultant relations to human activities are most commendably set forth.

The regional discussion begins boldly with the Arctic Ocean—a procedure certainly not traditional from an American point of view and somewhat startling even from a Danish. Perhaps it is an illustration of the response of a Nordic to his environment, but at any rate it is interesting and not without merit. Then follows a comprehensive treatment of North America, covering nearly 450 pages. Here again the scheme of giving a general introduction and then political divisions in detail is followed. A survey of the structure and geological history of the continent is given, but principal emphasis is placed on climate and vegetation; in fact, natural regions are determined chiefly upon the basis of native vegetation. The general culture map of "old North America" presents the following regions as indicative of the broad culture areas of the continent: Eskimo, Northwest Coast, Northern Forest, Eastern Forest, Prairie, Plateau, California, Pueblo, Mexico and Central America, and the Antilles.

The regional discussions are based on political units and are well correlated with the general principles given in the introductory chapters. The treatment is somewhat encyclopedic in method, and, as is to be expected in a work of this character, is not completely free from error. Yet it gives much emphasis to causal relations and to the geographic influences resulting and so ranks high as a real geographic study.

N. A. Bengtson

New Zealand Vegetation

L. Cockayne. **The Vegetation of New Zealand.** xxii and 364 pp.; maps, ills., bibliogr., index. *Die Vegetation der Erde*, Vol. 14, Wilhelm Engelmann, Leipzig; G. E. Stechert & Co., New York, 1921. $5.00. 10 x 7 inches.

L. Cockayne. **New Zealand Plants and Their Story.** 2nd edit., rewritten and enlarged. xv and 248 pp.; maps, ills., index. *New Zealand Board of Sci. and Art Manual No. 1.* M. F. Marks, Wellington, 1919. 8½ x 6 inches.

The region treated in "The Vegetation of New Zealand" comprises New Zealand proper and various small outlying islands. New Zealand proper, consisting of two large islands (North and South) and a third smaller one (Stewart), extends approximately north and south from latitude 34° to 47° S. (a distance of about 900 miles), or between latitudes corresponding to those of southern North Carolina and northern Nova Scotia respectively. The climate of the country, no part of which lies more than 100 miles from the sea, is insular, and its truly temperate character is suggested by the fact that tree ferns and many other plants, ordinarily associated with the tropics, range throughout. Both North and South Islands are characterized, in the main, by an extremely rugged topography, the mountains of the Southern Alps rising to elevations of more than 12,000 feet. Precipitation, on the whole, is abundant and evenly distributed through the year. Over most of North Island it exceeds 50 inches annually; along the western coast of South Island it is more than 100 inches; and only in the lee of the Southern Alps does it fall below 30 inches. The outlying islands include the subtropical Kermadecs (latitude 29°–31° S.) and several subantarctic groups, reaching to latitude 54° S.

At the time New Zealand was settled, the plant life of the islands was virtually an unopened book. During the century that has elapsed its flora has become revealed as one of peculiar interest in itself and of surpassing importance in its bearing on various geographical problems. Separated as New Zealand is by more than a thousand miles of open sea from the nearest continental land mass, Australia, it is scarcely surprising to learn that the majority of its plants are endemic—nearly 75 per cent of the vascular species. Somewhat more surprising, in view of its geographic isolation, is the exhibition of well-marked affinities by various elements

in its flora to floras in other parts of the world. In addition to an outstanding element of New Zealand origin, three distinct elements of extraneous origin are present, namely an Australian element, a Malayan element, and a subantarctic element—the latter including many genera and even species common to subantarctic South America. No general discussion of the plant life of New Zealand would be complete that neglected to consider facts such as these, and, from the standpoint of floristic plant geography, they stand out as being of paramount importance. The present work, however, is written primarily from the standpoint of ecological plant geography. It has to do with the environmental relations of New Zealand plants rather than their taxonomic relations. Furthermore, its chief theme is the vegetation of New Zealand, as distinguished from its flora; and individual plants are dealt with chiefly as integral parts of the plant covering as a whole rather than as floristic units. In the words of the author the aim has been "to present as vivid and accurate a picture as possible of the actual vegetation of the country. This surely is the first step in a plant-geographical description of any country. And it is the more necessary in a region, such as New Zealand, possessing a truly virgin vegetation which is rapidly becoming modified, or even destroyed."

The unquestioned success with which the author has achieved this aim may be attributed in no small measure to his admirable method of presentation. In taking up the plant life for various sections of New Zealand, in each case the description of the vegetation itself is prefaced by a description of the more important plants and groups of plants entering into its composition, with reference, more particularly, to their growth forms and other features of ecological significance. Especial emphasis is laid on the "leading physiognomic plants," i. e. those that predominate the landscape and determine the general physiognomy of the plant cover. Four phytogeographical sections are distinguished, namely the seacoast, the lowlands and lower hills, the high mountains, and the outlying islands.

Except for the high mountains and the drier sections of South Island, practically all of New Zealand proper was originally forested. Two ecological types of forest are distinguished, namely hygrophytic rain forest and mesophytic southern-beech (*Nothofagus*) forest, the former being widely distributed throughout the entire region and relatively much more important than the latter, which is confined to the two southern islands. Both types are made up almost wholly of evergreen trees, the practical absence of deciduous species being a noteworthy feature. Characteristic of the rain-forest type are the presence of taxaceous trees, with one or another species frequently predominating; the great abundance of tree ferns and the vast number of ground ferns; the luxuriant growth of lianes and various epiphytic seed plants; the density and storied arrangement of the undergrowth; and the profusion of filmy ferns, mosses, liverworts, and foliaceous lichens. It is essentially the type of forest found elsewhere, for the most part, only in the humid tropics. It exhibits considerable diversity from place to place; but this diversity has to do less with the ecological aspect of the forest than with its taxonomic composition, on the basis of which, chiefly, a number of different rain-forest associations are distinguished. In addition to the forest associations, the lowlands and lower hills support a wide variety of shrubby and herbaceous associations. The seacoast, probably unsurpassed in physical diversity by any area of similar size, presents divers seaweed and other marine associations; associations of gravelly and shingle beaches, of sandy beaches and dunes, of rocky cliffs and promontories; mangrove swamps, coastal thickets, and scrubby forests. The high mountains support a variety of distinctive and, to a large extent, unique types of vegetation. The outlying islands afford many features of fascinating interest, quite distinct from those of New Zealand proper. All of these and other features are described in graphic detail, the work concluding with chapters on the effect of settlement upon the plant covering of New Zealand, the flora of New Zealand and its distribution, and the history of the flora.

The book is written more especially for the scientific reader. The other book by the same author, entitled "New Zealand Plants and Their Story," is now in its second edition. This little book, designed primarily for the non-technical reader, affords a fine example of popularized scientific writing.

G. E. NICHOLS

A STANDARD WORK ON OCEANOGRAPHY

JULES SCHOKALSKY. **Okeanografia [Oceanography].** xiii and iv and 69 and 614 pp.; maps, diagrs., ills., bibliogr., indexes. Petrograd, 1917. 10¼ x 7½ inches.

The oceanographical work of the President of the Russian Geographical Society is too well known in the scientific circles of two hemispheres to need introduction here. What may not be passed over in silence is the abnegation of the man, who in the midst of personal misfortune and the misfortunes of his country can yet maintain his service to science, and this, as much as the value of his works, commands respectful attention.

The present work on oceanography begins with an introductory chapter on the history of the subject and then includes the following subdivisions: (1) distribution of lands and seas (pp. 3–10); (2) level of oceans and seas (pp. 11–17); (3) submarine relief (pp. 17–51); (4) nature of the ocean floors (pp. 52–64); (5) composition and salinity of the sea waters (pp. 67–116); (6) temperature of the sea waters (pp. 117–213); (7) transparency, color, and phosphorescence (pp. 213–225); (8) waves (pp. 226–284); (9) tides (pp. 284–403); (10) currents (pp. 405–564). There is a conclusion of 15 pages.

This glance over the subdivisions of the work and their respective proportions indicates the special interests of the author. Historian of geography as he has shown himself in many international congresses, he has expended much care over the introduction of 69 pages. It is richly and accurately informative. Observations too often forgotten are related, as, for example, the data on the vertical distribution of temperature gathered by the Dupetit-Thouars expedition in the *Venus*, 1836–1839; others, generally unknown, there find place, as the similar determinations carried out by the Russians Krusenstern in the *Nadejda*, 1803–1806, and Kotzebue in the *Rurik*, 1815–1818. Part of the originality of the book, indeed, lies in the light thrown on Russian oceanographical work. It is not merely a matter of *amour propre*. The Russian marine is not to be measured by the modest size of its merchant fleet: it has included in its ranks, besides eminent naval commanders, many distinguished savants; its hydrographic charts and memoirs bear comparison with the best of similar work produced by other nations. It is because he has drawn so largely therefrom that Schokalsky has given us a treatise that happily completes the better-known works of Thoulet and Krümmel. But this proper care in giving a place to his compatriots does not preclude recognition of the debt that oceanography owes to other nations. The American reader will appreciate the reference to Maury, the founder of marine meteorology; to Bache, who in 1844 initiated the study of submarine lithology; and to the U. S. Coast and Geodetic Survey and the Hydrographic Office. Text and figures bear witness to frequent borrowings from these sources.

Besides the figures that one finds in all oceanographical treatises there are many original ones drawn by the author. There is, for instance, the comparative curve of salinity, precipitation, density, temperatures of water and air for the Atlantic Ocean between latitude 60° N. and 60° S. which portrays in a remarkable way the characteristics of the zones of calms, the trade winds, and the westerlies (p. 89). Not less ingenious are the graphs which show on the same meridian in the southern

seas almost complete identity of oceanographical elements in spite of a range of 16° in latitude (from 54° 27′ to 70° 2′ S.) (p. 155). Again we may mention the drift of bottles in the Caspian (p. 536) and in the Japan and Okhotsk Seas (p. 550); the diagram of seiches observed August 25, 1911, at Sevastopol (p. 283); and the tidal map of the French coasts of the Channel (p. 380).

It is to the study of the movements of the seas—waves, tides, and currents—that the author gives most space; less, however, to description, qualitative and quantitative, of these phenomenon than to theoretical explanation. There one sees his mathematical leanings: he is too inclined perhaps to assign very special causes to infinitely complex phenomena; too scrupulous to come to a conclusion after having considered several doctrines; too lengthy sometimes for our taste, not less than 12 pages, for instance, being devoted to Ekman's theory of currents.

A consequence of this disproportion is the excessive brevity of certain parts. Speaking of the depths of the Indian Ocean apropos of the 7000-meters deep off Java, the author does not signify the tectonic interest attaching to this long trough between two arches. Among the many maps in the book it is surprising that one of the variations of temperature of the surface of the seas such as Murray and Schott have given is not included. Why, in speaking of the Humboldt (p. 547) and Benguela (p. 527) currents and the bringing up of cold water from the bottom to the surface, does he not mention, if only in passing, Dinklage and his theory of "Auftriebwasser"? Can one affirm without reserve that the difference of density between the Atlantic and Mediterranean waters provokes a difference of level which results in a surface current from the latter into the former (p. 169)?

The exposition of facts often gains by reference to their immediate consequences. The author notes the effect of the temperatures of the Norwegian Sea during 1901–1905 on the fishing industry and on the growth of the fir tree. When describing the slight salinity of the Gulf of Finland, waters so well known to him, might he not equally well recall that one finds there 67 species of fresh-water fish? Nor does he mention the fact that the warm surface waters of the White Sea in summer support an entirely different fauna from that of the colder waters below, a fact established by the fine work of Knipovitch. The value that such biological details add to the physical facts has recently been shown by R. C. Murphy in his description of the Humboldt Current (*Geogr. Rev.*, Vol. 13, 1923, pp. 81–84).

In short one regrets, and it is the only reproach that can be made, that the author has tended too much to sacrifice description to theory, color to exactitude; that he has not taken the opportunity to vivify the too austere excellence of his admirable work.

P. Camena d'Almeida